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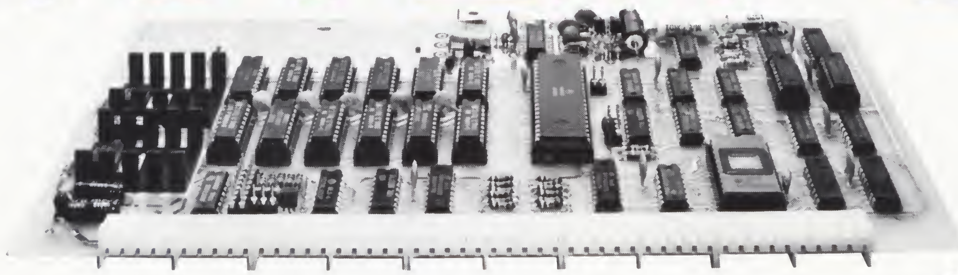
SYSTEM-50



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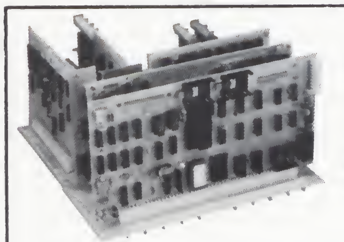

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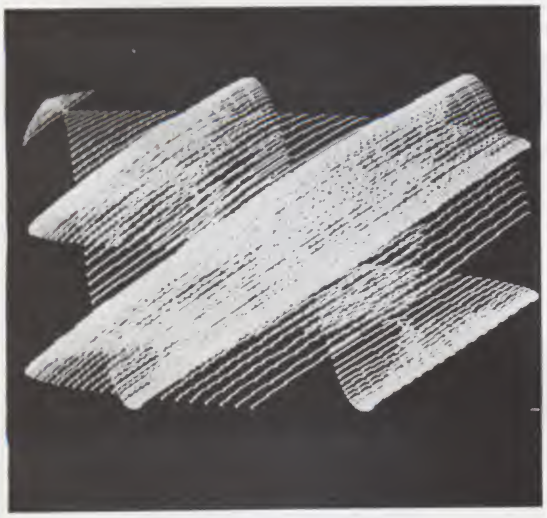

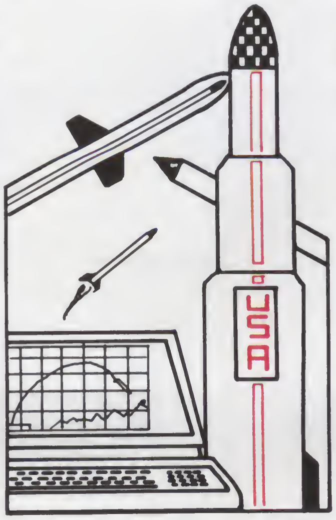

Page 134.

This month's cover:

What's a working microcomputer on a Florida beach doing on the cover of this month's issue? Have the editors of *Kilobaud Microcomputing* stayed out in the sun too long?

No, we aren't recommending that you pack your Apple II in with the suntan lotion, blankets and sand pail and shovel the next time you head for the beach.

This cover photo, which is a dramatic departure from the workstation setting where microcomputers are normally found, is the work of nationally known outdoor and wildlife photographer Ozzie Sweet. His credits include cover shots for such major publications as *Time*, *Newsweek* and *Look*. And while he has done covers for technical and scientific publications before, this marks the first time that he has worked with a computer as a model.

We think you'll agree that he brings a unique perspective to the world of computer photography. How better than in a seashore setting to illustrate the versatility of the Apple II "go-anywhere, do-anything" computer?

We commissioned Ozzie for this special Apple issue cover "between innings" of his tour this spring of the major league baseball training camps in Florida, where he was on assignment for Topps, the baseball cards people.

Besides being a talented photographer and creative artist, Ozzie is a prolific shutterbug. One magazine photo editor with whom he has worked described him as "the Henry Aaron and Babe Ruth of the magazine cover business."

Indeed, he has had over 1700 magazine covers published. We here at *Kilobaud Microcomputing* are pleased to be included among that number.

—The Editors

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By Wayne Green

Are Shows Worth It?

Consider The Time And Expense

Show Hoopla

Having just managed to survive an intensive round of computer shows in the spring, I see more of them springing up—like mushrooms—this fall. Are these affairs really worth your trouble and expense to attend?

If you are a dedicated hobbyist and want to meet and talk with the people in the industry, I can see where you might get your five or ten dollars' worth at a show. Of course, you'll have to deal mostly with the smaller firms, since the big ones have pretty much been ignoring shows.

However, it is not likely that you'll see anything new. New equipment is no longer rushed into being for a show. Back when we had one big show a year, there might have been some justification for getting a new product ready a few weeks early so it could be shown at the show. Today, with dozens of shows a year, what's the difference?

Even the largest shows can't bring you the variety of merchandise you find advertised in one issue of *Microcomputing*.

Apple ran a series of small shows this last spring, and I assume this will continue if the enterprise was successful. Oddly enough, I've heard nothing from Apple, or from any of the exhibitors, about the success of the shows. The Boston Computer Society recently ran an independent Apple show in Boston. It was very small, but certainly successful, drawing a good crowd. The first independent TRS-80 show in New York was moderately successful, although lacking somewhat in crowds due, I surmise, to massively absent advertising and promotion.

The big show of the year was NCC in Chicago. This drew about 80,000, hundreds of whom were interested in microcomputers. This is a show for data processing people; no hobbyists or end users wanted. Many of the micro firms exhibit, in an attempt to overcome inferiority feelings, rather than for practical reasons.

You see, the maxi and even the mini people are so condescending about micros that many micro firms feel they have to exhibit at NCC just to prove they are really in the business. The maxi crowd is not impressed by these "toy" merchants. Just as the Cadillac is America's answer to the inferiority complex, so NCC is the answer for our field.

What was really new at NCC this year? Little.

I also go to see the Consumer Electronics Show (CES) because sometimes in attendance are a few Japanese firms which seem confused about where to exhibit computers to reach the American market. Hitachi appeared this year, not sure what to do about the American market, yet afraid to lose out on it.

The Japanese Dilemma

With IBM due to show their new microcomputer soon—and similar threats from DEC, Digital Group and other minicomputer firms—the Japanese are beginning to panic. They have had some nice equipment available, but have not figured out how to get into the swing of the growth here. Apparently, they have not managed to find a consultant to explain to them how to enter the American market.

It is rapidly becoming much more expensive to get started here. Today it will cost about ten times as much as it would have a year ago to get going. By next year that entry fee may go up another order of magnitude. Soon it is going to tax the resources of even the enormous Japanese corporations to get a significant share of the US microcomputer market.

By the way, the rumors of IBM using the S-100 bus were just that . . . rumors. Using the S-100 would have been a very shrewd move. An even better move would have been TRS-80 compatibility.

The price of the Japanese indecision is high. There is no question that the American market for small computers is not only going to continue to grow, but also to escalate, eventually to behemoth proportions. The key to dominating the world market will lie in quantity production for the US market, which is developing first. Large-scale production means lower prices and faster development of new technology, giving the firms in the US market a decided worldwide advantage. Whichever firms dominate the US market will probably come to dominate the European and Asian markets too, so the Japanese have a very serious problem.

The selling of consumer computers in the US is a new field and has baffled the Japanese so far. Much of the business is being done via Radio Shack stores, where they have no entry. Then comes the 2000 or so computer-specialty stores, many of which are underfinanced and difficult to deal with. A few tries have been made to sell via department stores, discount chains, office supply stores and so on, but the fact is that getting into the American consumer-computer market requires some very creative thinking, something we have not seen in abundance from Japan.

Complicating the sales problems for computer stores is the number of salesman hours to sell a system, and the similar number of hours required in after-the-sale handholding. Furthermore, there is the demand for instant service. Any business buying a computer soon finds that everything stops when the computer stops, so service is needed in minutes, not hours or days. This is a situation which has not yet been adequately tackled by any firm.

One of the reasons I'm interested in starting a "college" to train people in micros is the incredible need for people for our field. We need programmers, salesmen, technicians, advertising help, marketing help and so on. The need is desperate and growing as fast as sales. We could use a few thousand people with micro backgrounds to help the industry grow. We won't get the services we need unless we have some way of mass-training people. We are having to make do with poor service, which is costing more and more to buy.

Software firms have the same problem facing hardware firms—dealers interested in carrying the product, but without the cash to stock it and the facilities to sell it. This has seriously slowed the growth of software publishers, yet without this software, the sale of hardware is in-

evitably slowed. It's a Catch-22 situation.

Instant Software, which is one of the divisions of Wayne Green, Inc., could grow much faster if more people could be found to make things happen. I'm pressured every day with demands for more programmers, salesmen, marketing people, advertising people, promotions people, microcomputer technicians, digital audio technicians, typesetters, graphics artists, copywriters, documentation writers and so on. We could easily use 50 more people in Instant Software (though I don't know where we'd put that many!), and I'm sure we are not unusual in the industry. Most of the people I talk with are having the same problem.

In Plain English

One of the major problems facing computer stores in selling systems has been the language barrier. Something strange happens to computerists when they learn about computers—they lose all ability to communicate in plain language.

It is my thesis that there is a serious need for a magazine about computers which is written and edited in English, not computerese. This magazine will become a fact starting with the October 1981 premier issue. The idea is to make information on the uses of desktop computers available to businessmen. The magazine will concentrate on success stories of business applications for our small computers.

By buying a couple more buildings and expanding the editorial offices of Wayne Green, Inc., we have made room for the staff of *Desktop Computing*. We are still looking for more help—space sales help, editing, writing, typesetting and so on.

Naturally we are looking for articles for *Desktop*. They should be double-spaced, generously margined and should be written with no computer buzzwords. *You* can do it. Readers will want to know what hardware and software systems really work, how long it takes to get on line, the costs, savings, benefits, problems and so on. We'll entertain some disaster reports too, but for the most part *Desktop* will be upbeat.

The businessman of today knows that he needs a computer, but doesn't know what to get or even how to find out. *Desktop* will bring him this information, all in plain language.

Readers of *Desktop* will want to know your successes with software, with accessories and with various systems. They'll want to know how to network computers so they can provide distributed processing, communications, bulletin boards and all of the lovely things our micros can do. The magazine will not be restricted to micros, since the dividing line between them and low-end minicomputers is a fuzzy one at best. It will be aimed at the businessman—small and large—letting him know in English what is going on with computers.

I really need your help in getting articles, subscribers and advertising. In return, I think I will be able to help the whole computer industry to grow and surmount the cash and people problems now slowing it down.□

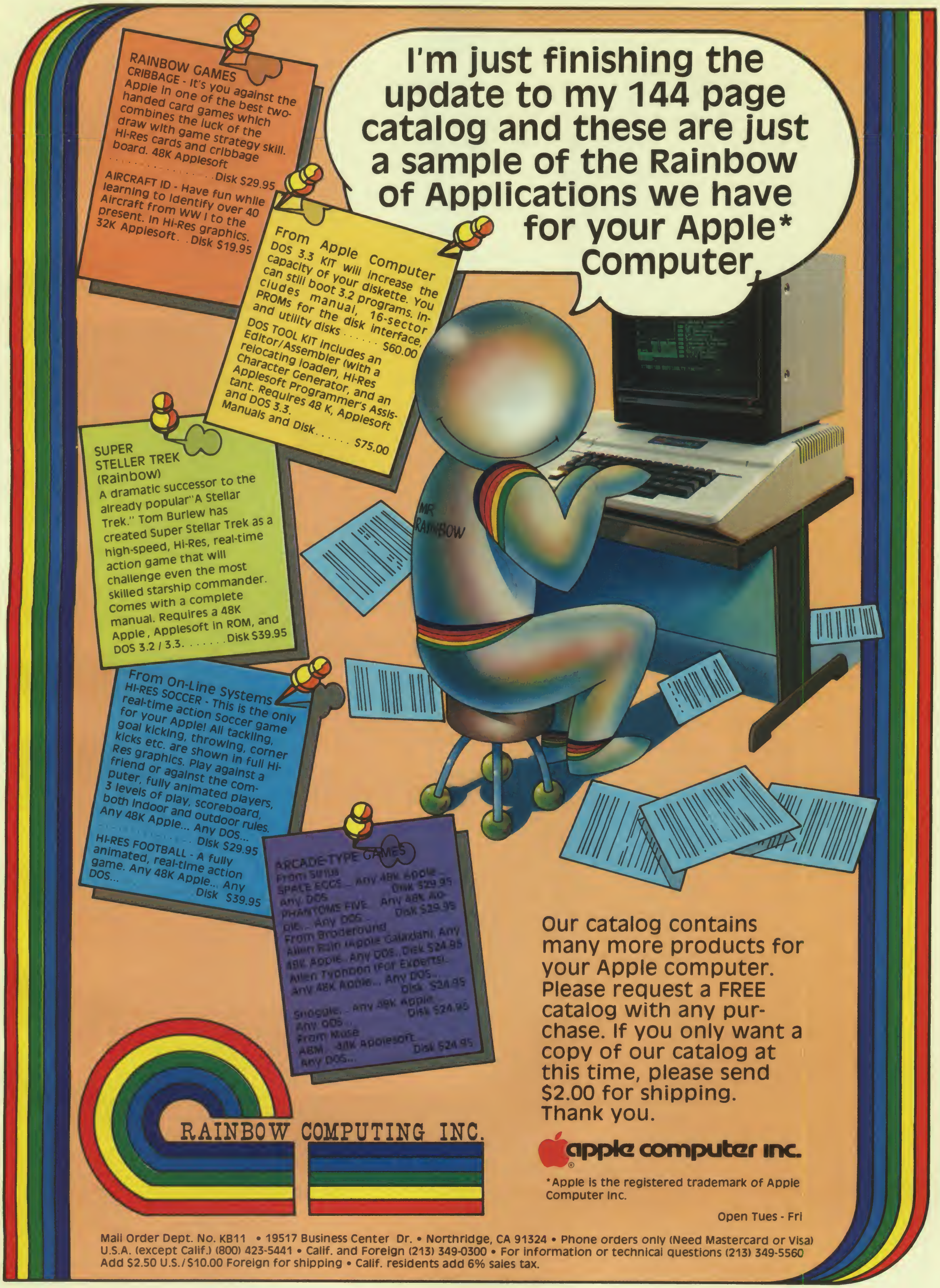
MICRO QUIZ

What Does This Program Do?

When the following program is executed, what will be printed? (If there are any embedded blanks in the string which is printed, replace each blank by the letter b with a slash through it: ƀ.)

```
A$ = "NECSL"
B$ = left$(right$(A$,3),2)
C$ = mid$(A$,2,2)
B$ = C$ + B$
print B$
```

(answer on page 217)



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By Robert W. Baker

Commodore Colors NCC

Introduces New 8032, Micro-Mainframe

Unfortunately, I couldn't make it to NCC in Chicago last May, but I did receive several new product announcements from Commodore. For those that haven't heard, a few new goodies are on the way that should create quite a stir. Pricing and availability were to have been announced at NCC, so watch for further details.

A Color 8032!

First of all, Commodore has announced a color version of their 80-column 8032 system. The new color 8032 has a high-resolution, direct drive RGB (red, green, blue) color monitor. It is supposed to provide a crisp, easy-to-read display in both text and graphics modes.

Normally, the color 8032 system displays green characters on a black background, just like the regular 8032. Using the control key, the user can then display information on the screen using a variety of foreground and background color combinations. You can even use reverse field with colors for highlighting. Color displays can be generated character-by-character, either directly by the user, or under program control from within a single print statement.

In all, there are eight colors (black, blue, green, cyan, red, magenta, yellow and white) available for the background color and foreground display. This gives you 64 possible combinations in each of the three character modes (text, graphics and plot). In the graphics mode there's a 160 × 100 point resolution for creating a high-resolution display.

You should be able to run all software developed for the standard CBM 8032 on the color version without modification. Fortunately, the standard CBM version 4.0 BASIC interpreter remains unchanged. However, the new color system contains an enhanced 32K Screen Edit ROM to provide the color handling capability. If a program uses any Screen Edit routines, it may need some work to run on the new color system.

Address correspondence to Robert W. Baker, 15 Windsor Drive, Atco, NJ 08004.

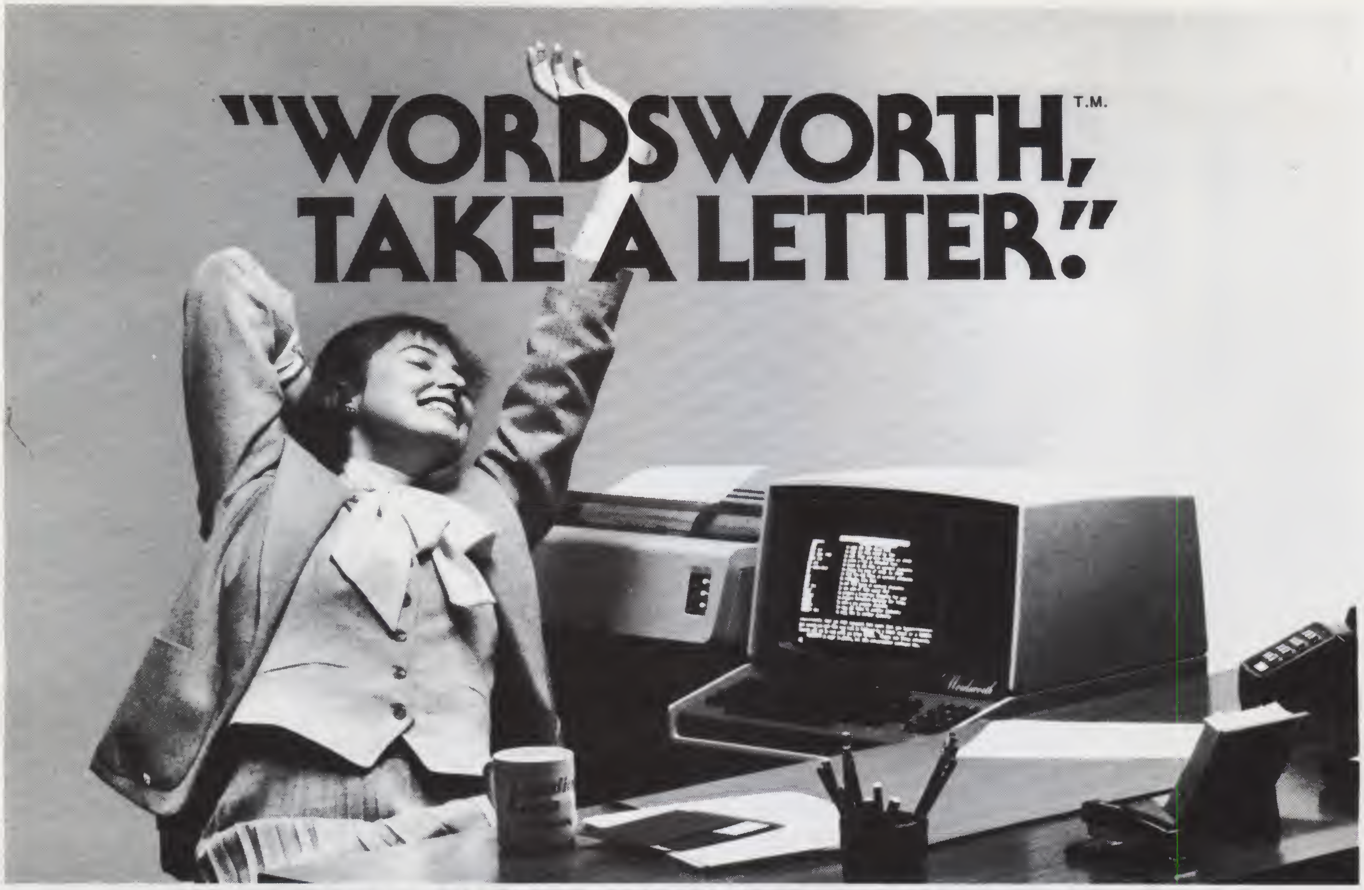
Commodore's new CBM 8032 color microcomputer.

Micro-Mainframe

The other new system from Commodore is their Micro-Mainframe. This is a new-generation computer that combines the power and languages available on mainframe systems with the low cost of microcomputers. Applications developed on the Micro-Mainframe can be transmitted to a mainframe system and executed without modification.

The new computer is based on the standard CBM 8032 with the familiar 12-inch green phosphor display, 73-key typewriter-style keyboard, and full cursor controls. However, the Micro-Mainframe is a pseudo 16-bit 6809-based system with 36K ROM, 96K user RAM and 2K screen RAM (134K total). The system supports all current CBM peripherals except the C2N cassette recorder. Additionally, a new communication facility has been included to support standard RS-232C interfaces with speeds up to 9600 baud. All files are stored in true ASCII format for communication and compatibility with mainframe systems.

An extensive software package for the new system has been developed by Waterloo Computing Systems Limited to meet the requirements of the University of Waterloo in Waterloo, Ontario, Canada. This portable software is particularly suited to microcomputers, but identical versions are available on medium- and large-scale systems. Thus, a user is not limited by the capacity of the micro; the identical program will run without modification on many of the largest and fastest



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systems available.

The software package consists of interpreters for various languages, an editor, an operating system (supervisor) and an assembly-language development system. The four language interpreters include Waterloo microBASIC, microPascal, microFORTRAN and microAPL. COBOL is not yet available, but is under development. These language interpreters have been designed specifically for teaching computer programming. Their design emphasizes good error diagnosis and debugging capabilities which are useful in educational and other program development environments.

Waterloo microBASIC includes ANS Minimal BASIC, with certain minor exceptions, and several extensions. Such things as structured programming control, long names for variables, sequential and relative file capabilities, integer arithmetic, debugging facilities and convenient program entry and editing facilities have all been included.

Waterloo microPascal is an extensive implementation of Pascal, corresponding very closely to draft proposals being produced by the ISO Pascal Committee. The ISO draft language is a refinement of the language originally defined by Wirth, varying only in minor aspects. This implementation includes sophisticated features such as text file support, pointer variables and multidimensioned arrays. A significant feature of Waterloo microPascal is its powerful interactive debugging facility.

Waterloo microFORTRAN is a special dialect designed for teaching purposes. It has many of the characteristics and much of the flavor of normal FORTRAN, but varies significantly from established standards for that language. It has many of the important characteristics of the WATFIV-S compiler, which is widely used on IBM computers, plus some features from the new FORTRAN-77 definition. It supports subroutines and functions, multidimensioned arrays, extended character string manipulation, structured programming control and file I/O. In addition, the interpreter provides a powerful interactive debugging facility.

Waterloo microAPL is intended to be a complete and faithful implementation of the IBM/ACM standard for APL with respect to the syntax and semantics of APL statements, operators and primitive functions, I/O forms and defined functions. System commands, system variables and system functions are those consistent with a single-user environment. There are no significant design limitations on the rank or shape of arrays or name length. The shared variable processor is omitted. Extensions include system functions supporting files of APL arrays. APL equivalents of BASIC features PEEK, POKE and SYS are also included.

A text editor known as Waterloo microEDITOR, which is suitable for creating and maintaining both program and source data files, is included. It is a traditional line-oriented text editor with powerful text searching and substitution commands, including global change. Full-screen support and special function keys allow text to be altered, inserted and deleted on the screen without entering commands. Facilities for repeating and editing previously issued commands further enhance the usability of the editor.

Commodore's new Micro-Mainframe combines the power and languages available on mainframe systems with the low cost of microcomputers.

Disk-oriented assembler and linker programs, the Waterloo 6809 Assembler and Linker, are included to support development of general-purpose Motorola 6809 machine-language programs. The Assembler supports syntax and directives for Motorola 6809 assembly language and includes powerful macro capabilities. In addition, the Assembler supports pseudo op codes for structured programming control, long names (labels) and the ability to include definitions from separate files. The Assembler produces both listings and relocatable object files.

The Linker allows the combination of an arbitrary number of relocatable object files to produce an absolute loadable and executable program file. Since it is disk-oriented, the Linker is capable of building programs which are larger than the RAM work space available. The Linker supports building of programs in segments or banks for operation in bank-switched RAM memory, as well as building of programs for operating in normal RAM memory.

The Waterloo microSUPERVISOR is an operating system designed for single-user microcomputer environments. It includes a monitor, library and serial line communication support. The Monitor program supports loading of Linker-produced program files into bank-switched RAM memory or normal RAM memory. It also provides facilities which are useful for debugging machine-language programs. There are commands to display or alter RAM memory and 6809 registers, using full-screen features for ease of use. In addition, another command permits disassembly of 6809 instructions into assembly-language mnemonics.

A library of functions and procedures is supplied for general use by other programs included in the software package. The Library includes support functions for input/output operations to the keyboard, screen and peripheral devices. Other elements of the library provide floating-point arithmetic, fundamental trigonometric functions and several general-purpose utility functions.

A Serial Line Setup program is included which provides selection of programmable characteristics, such as baud rate. The program includes support for establishing communication with a host computer, through a serial line, for accessing the host's files or peripheral devices.

Reference manuals, textbooks and instructor's guides are available for each software component of the system. The system was on display at the NCC show, but deliveries are not scheduled till the end of the year.

New Software

Several new software packages were also announced at NCC. Wordcraft 80 is Commodore's new word processor package for the 80-column systems. It is entirely different from the familiar Word Pro programs, but provides similar results. With Wordcraft you can display text in the exact form that it will be printed. Text can be easily edited and the format immediately verified on the display, without printing the document. In addition, page layouts of up to 117 characters wide by 98 lines deep can be accommodated by the automatic scrolling of text on the screen. Large documents are divided into chapters, with one chapter at a time held in the computer's memory.

During text entry Wordcraft will not break words when the right-hand margin is reached; the entire word is moved to the next line. Text editing is accomplished by a few simple keystrokes. Standard features include character, word and paragraph deletion or insertion plus block movement of text from one area to another. This word processor supports character string search and replacement within a chapter on the first of all occurrences. Wordcraft also handles tabs, decimal tabs, multiple levels of indention and automatic centering. Tabs and margins can be changed anywhere throughout the text without disturbing the previous settings. Half-line printer movement for subscripts and superscripts is also supported from within the text.

Separate paragraphs or sections of text can be easily merged to form finished documents. Name and address files, or any information, can be merged into a standard form letter and then printed. The entire process is automatic once the

Most people just sell disks. I sell you a complete system, and then I help you make it work.

It's called support, and it's a rare commodity in the microcomputer world.

It's also one big reason why they call my programs "the standard of the industry."

I'm Irwin Taranto, the one who changed the TRS-80* into a serious business computer. When you buy my TRS-80 systems (or, for that matter, one of my own computers that says "Taranto" on it), you buy me.

You buy my experience in making TRS-80 systems work in thousands of businesses around the world.

You buy the corrections, modifications and upgrades I constantly make on my TRS-80 systems.

And you buy my telephone number. You see, most of those thousand businesses needed a little help getting their systems up and going, and they called. We answered all their questions, and talked them through their problems. Every time the questions got really tough or really unusual, I'd answer them myself, on the phone, right then and there. I still do.

That pays off in two ways. It makes sure you get your systems working. It also alerts me to any little operating inefficiencies I might have designed into my systems. If there are any general business programs anywhere in the world, of any kind, that are checked out any better than my TRS-80 systems, I'd like to know about them.

I turned the TRS-80 into a serious computer.

The Model I, II and III business systems.

So far, I have six systems for the Model I, at $99 each:

Accounts Payable	General Ledger
Accounts Receivable	Payroll
Invoicing	Inventory Control

For the Cash Journal option on the General Ledger, add $50.

I also have six systems for the Model II:

General Ledger/Cash Journal	$ 299
Accounts Payable/Purchase Order	349
Open Accounts Receivable/Invoicing	349
Additional for Sales Analysis	100
Balance Forward Accounts Receivable	399
Payroll, without Job Costing	299
Additional for Job Costing	100
Inventory Control	399

For the Model III, we offer expanded versions of the six Model I systems, at $199 each.

Just call the number below and I'll send you any or all of the Model I or Model III systems by return mail. If you call about the Model II, I send you a questionnaire before I'll send you any systems. That lets me individualize the programs to your specific applications.

Why I call them "systems," not "programs."

There's a one-word answer: interaction. Each of the three sets of programs links to the General Ledger, and wherever it's useful, they cross-link to each other. For instance, "Sales Analysis" figures in a salesman's commission rate, so it links to "Payroll." Since it computes profitability within product categories, it links to "Invoicing."

That's what a system is. And that's one big difference between the Taranto TRS-80 business systems and somebody else's collection of business program disks.

If you like, I'll sell you the hardware, too.

I offer the TRS-80, Model II, along with selected peripherals. If you buy the computer from me, you get some extra advantages — hardware that's absolutely tailored to the programs, plus even more hand-holding from Taranto & Associates. The equipment won't cost you any more.

I can sell you a truly serious, completely supported, thoroughly proven business computer system for as little as $8000, hardware and software both.

There's nothing else like it in the market. Believe me, it's a far cry from that collection of program disks they're selling down the street.

Taranto
& ASSOCIATES, INC.

The Total System Store™

121 Paul Drive, San Rafael CA 94903.
Outside California, toll free (800) 227-2868. In California, (415) 472-2670.
Authorized dealers throughout America.

*A trademark of the Tandy Corporation

✓See List of Advertisers on page 194

files and form are set up.

Any properly interfaced letter-quality printer can be used with Wordcraft 80, and proportional spacing is supported. Single sheet stationery or continuous forms can be used. You can specify a single page, chapter or whole document for printing. At print time you can also specify underlining or heavy printing for those text areas so defined. With certain printer interfaces, background printing is allowed. This means that you can be working on one document while another is being printed.

Headers and trailers can be placed on each page and changed from chapter to chapter. They can even be specified in book fashion, alternating for left and right-hand pages. Page numbering is automatic and the system keeps track of all pages, even when a new chapter is added or inserted into a document.

Included with Wordcraft 80 is a special link program that lets the user incorporate VisiCalc data into a Wordcraft document. This data can then be edited like a standard document.

Wordcraft 80 is supplied with a comprehensive user's manual, a set of training cards and a pocket reference guide. The program can store about 350 pages of normal text on one standard 8050 disk drive. Alternately, a Commodore 4040 disk can be used. Retail price for Wordcraft 80 is listed at $395.

Another new software package from Commodore is a Dow Jones Portfolio Management System (PMS). This package provides the serious private or professional investor immediate access to pricing and financial information available through the facilities of the Dow Jones News Retrieval Service and additionally functions as an accounting and control system for security portfolios.

The system allows maintenance of stock portfolios, automatic valuation of positions in the portfolio, retrieval of current and historical quotes and displaying and printing of news stories from the previous 90 days. This data is available for over 6000 stocks and selected news categories in the Dow Jones databases. Media General Financial Services, a price, dividend and fundamental financial database, can also be accessed with this system.

PMS features easy-to-use screen data entry for buys, sells and cash transactions. A complete year-to-date transaction audit trail and portfolio summary report are standard. The system provides a graphics display of historical prices and a printed copy of news stories, historical prices and the graphic displays.

This software package will run on any 32K PET/CBM system (2001, 4032, 8032). A Commodore 4040 or 8050 disk and a modem are also required, while a 4022 printer is supported for optional printing. Retail price for this package is $149.95.

The last software package announced, Legal Time Accounting, manages the business side of a law firm, thus allowing lawyers to concentrate on their primary task. Specifically, LTA keeps track of client files, matter (case) files and associated log entries, which represent services performed for individual matters. LTA automatically posts log entries to the appropriate matter and prints individualized statements according to nine criteria. A number of options are provided to effectively use this information, once entered into the system. You can easily produce a list of clients or matters.

Client matter inquiry allows viewing all open log entries for a particular matter. A number of statistics and activity reports can be produced, including aging reports by both lawyer and firm. A utility section lets you set up fee and activity codes as well as perform normal housekeeping functions (such as disk backups).

LTA was designed to be easy to use, even for those with little or no computer experience. Additionally, the system closely follows the procedures used in a typical law firm. LTA handles about 500 active clients, 1500 matters and 2500 open log entries. It was designed for firms with up to ten lawyers. The program runs on the CBM 8032 with an 8050 disk, and will support a 4022 (or similar) printer. Retail price is $595.

VIGIL

Here's a new and very interesting software package for the PET/CBM from Abacus Software. Once I glanced through the documentation, I just couldn't wait to try it out. VIGIL stands for Video Interactive Game Interpretive Language. It's an easy-to-learn graphics and game language that lets you quickly create interactive applications. The language is patterned after the CHIP-8 game language available on the RCA COSMAC VIP computer, but has much greater capabilities. The VIGIL interpreter executes game programs and performs video graphics at much higher speeds than normally obtainable with BASIC.

VIGIL programs are entered and modified using the standard BASIC text editor built into the PET, the same way as programming in BASIC. If you have a printer, you can even list VIGIL programs just like normal BASIC programs. VIGIL was designed to read the BASIC text editor output stored in memory as its programs, just like PET/CBM BASIC. However, because of this, a little caution must be used in writing VIGIL program statements so BASIC keywords are not accidentally created where you don't want them.

There are more than 60 commands to manipulate graphics on the screen with 80×50 plot positions on a 40-column system. It is very easy to display and move patterns based on screen coordinates. Also, testing for pattern collisions or hits is easy. For most games, you can define standard graphics figures and display them anywhere on the screen with one simple command. Two registers are used to indicate the screen position where the pattern will appear. To move the pattern you simply issue the same command to erase the existing pattern, modify the registers containing the display coordinates, then issue the command again to display the pattern in the new screen position.

VIGIL commands consist of BASIC keywords and single-letter or character operands. One or more operands identify the data or internal registers to be used by the command. There are 26 internal registers, most of which can be used as desired for counters, pointers, etc. Besides graphics support, commands are also included for arithmetic, logical and random functions, accessing PET memory and loading and executing machine-language subroutines.

Two timers are available under program control. Input commands can read the full keyboard or a 4×4 portion of the numeric keyboard. The parallel user port can read joysticks or other attached devices. VIGIL can also create audio tones via the standard user port connection. Pitch and duration of the tone are pro-

gram-controlled and operate simultaneously with screen action.

The preliminary copy I received was very nicely done with good documentation. The final package will offer cassette versions for the three different ROM sets as well as a diskette version. Also, the final manual is supposed to be a 50-page printed booklet. Included with each package are nine sample programs that really help in illustrating how to use VIGIL for various types of games. VIGIL will sell for $35 in USA and Canada, $40 elsewhere.

For more information, write Abacus Software, PO Box 7211, Grand Rapids, MI 49510. This should really be of interest if you enjoy writing game programs or using graphics. You'll probably never want to program another game in BASIC after trying VIGIL.

Kingston KRK-2

In recent months a number of new products for the PET/CBM have been entering the US from Europe and other parts of the globe. One new hardware addition is the KRK-2 module from Kingston Computers Limited in England. The module is really three devices in one: a keyboard reset, full keyboard repeat and a keyboard clicker. Actually, there is even a fourth feature—provisions for sound generation. All features are provided by a single hardware module but operate independently.

Basically, the KRK-2 package consists of a small printed circuit board that connects between the PET main logic board and the keyboard cable. There are no modifications to be made to the PET itself. Instead, a rather unique concept is used where one IC is removed from its socket and then reinserted with a small, flexible, printed circuit pad between the IC and the socket. The other end of the printed pad then connects to the KRK-2 board. This effectively breaks several connections to the IC and routes them through the logic on the KRK-2 board.

Other cables from the module connect to the second cassette port for power and to a small speaker that is mounted inside the PET. All connectors have color-coded stickers to aid in matching the correct cables.

New features added by the small module include the RESET function, which is activated by holding down the RUN/STOP and = keys at the same time. The PET will return to the machine-language monitor and can be returned to BASIC by the X command. The reset function is a BASIC "warm" start as previously documented in various newsletters and articles. It does not destroy your program in memory.

After the reset, you have two options: restart your program from scratch or attempt to continue. To restart, simply enter a CLR command followed by RUN. Details on how to reset the microproces-

↙See List of Advertisers on page 194

sor stack and attempt to continue a program are given in the documentation.

The repeat key function is available from the time the PET is first powered on when the KRK-2 module is installed. There is nothing you have to do to enable the function; just hold down any key till it repeats. The hardware even provides two adjustments to tailor the repeat speed and sensitivity to your particular taste. The repeat is set up before delivery at a reasonably gentle pace so you can enjoy the repeat function and yet maintain contact with the cursor.

Bear in mind that you must compromise between something that's ideal for joystick-type games but useless for normal typing and something ideal for typing but boring and slow for games. The time delay between holding down a key and the start of the repeat action is two seconds maximum.

The key click function can only be activated after a POKE 59456,247 is entered. Thereafter, the feature can be enabled by holding down the RUN/STOP and < keys at the same time. It is disabled by holding the RUN/STOP and the space bar. Once enabled, a simple click sound verifies each keystroke for much nicer touch typing.

There are three ways of creating noise and/or music under program control with the KRK-2 module. The simplest is to repeatedly POKE the cassette port at location 59456. This is a far cry from "music," but can prove useful.

The second method is by direct control of the MICE TRO music generator. A listing of a very simple program to accomplish this is included in the documentation. The form of each note created by the music generator is determined by three parameters poked in memory prior to calling the routine via an SYS command. Two of the parameters determine the pitch, while the third determines the length of the note (up to four seconds).

The last method of producing music is by using the complete MICE TRO program that is included with the KRK-2 package. This program provides all the interface and control for the simple machine-language program provided in the manual. It implements an entire language for creating, editing, playing and saving music pieces.

Remember that the methods of generating sound via the KRK-2 module are not compatible with programs with sound written in the US. Most PET owners use the CB2 line on the user port to generate sound with an external speaker and/or amplifier.

As with other products I've seen from Kingston, the documentation is excellent and the product is first class. The complete KRK-2 package is $119.50 and is available from Microtek, Inc., 9514 Chespeake Drive, San Diego, CA 92123. If you are only interested in the keyboard repeat, a KRK-1 module is available for $39.95.□

By Walter Koetke

Educators' Recess

Something For Everyone In Minnesota

You're Not Alone

The spectrum of educational computer applications is already quite large. At one end are those who resist all forms of computer support for a variety of personal reasons. At the other end are teachers making daily use of Logo in the elementary classroom. And there are many educators at every definable level between these extremes. This article is a collection of personal observations on the current state of the microcomputer explosion and its impact on the precollege educational community.

Last May I attended the annual meeting of American Educational Data Systems (AEDS). As an organization, AEDS' interest is all educational applications of computer technology. While the organization was once completely dominated by those interested primarily in administrative applications, the organization now focuses on the use of computers in instruction.

The 1981 annual meeting was held in Minneapolis, which is the home of the Minnesota Educational Computing Consortium (MECC). MECC (2520 Broadway Drive, St. Paul, MN 55113) produces some of today's best instructional software. It was featured in the March 1981 issue of *Creative Computing*, which provided a comprehensive picture of the organization and much of its available software.

The AEDS annual meeting was excellent, with several significant sections for anyone interested in instructional applications of the computer. The content of the meeting overshadowed the inconvenience of an older hotel with overcrowded and overheated meeting rooms. A participant at this meeting almost had to be impressed by the diversity of attendees' backgrounds and job titles. I spoke with superintendents, assistant superintendents, business managers, curriculum coordinators, directors of computer services, department heads, elementary and secondary teachers and even members of state education departments.

This diversity of job titles was exceeded by the diversity of experience with and knowledge of the various aspects of computer-supported instruction. I met several old friends who've been working with computers and kids for over 15 years. I met several others who still have serious doubts about ever allowing computers to be a part of their instructional programs. And you could find attendees with every level of computer-related experience and nearly every level of personal educational philosophy in between. No matter what your title and no matter what your background, you were not alone at the AEDS convention.

The AEDS meeting program met the needs of virtually everyone—and that was no small feat. In one section the audience was shown the printed output of a program written by a fifth grader. The presenter was very proud that under her guidance this rather clever student was able to produce a picture of a rocket ship and the printed countdown from 10 to 1. Audience reaction ranged from, "Wow, that's amazing—and he was only in fifth grade," to the sound of pencils breaking between clenched teeth as those with a little more experience fought to remain polite and not interrupt the presentation of an enthusiastic teacher.

I nearly chipped a tooth while biting my pen during this presentation, as I've had the experience of having some of my own programs reviewed and then ranked with others evaluated by the same reviewer. Not being selected as the author of the best program was no surprise, but discovering that the "best" program had been written by a fourth grader—a fact the reviewer still doesn't know—was more than a little humbling.

As more and more students are given free access to general-purpose computers, I suggest most of us shall be both pleased and astonished with the result. When a student is given a sophisticated intellectual tool, he can undertake sophisticated intellectual activities once thought to be the nearly exclusive domain of those more experienced and more educated.

Another presenter showed us how Logo can be used when working with elementary school children. As you can probably guess, audience reaction ranged from, "I've seen the salvation of education," to "that guy must be nuts." The audience included those who have long awaited the commercial availability of Logo and those who never before heard the word and had no concept of its implications for education.

Certainly the best case for Logo is made in Seymour Papert's *Mindstorms: Children, Computers and Powerful Ideas*, Basic Books, New York, 1980. I consider this to be the most important book published for educators in several years, and suggest it as required reading for all teachers and administrators. Papert does not accept the idea that computers should be used to help us better teach those subjects we are already teaching. His text addresses the issue that computer availability has significantly altered that which should be contained in a basic education. Computers should change what we teach, not just how we teach. Do read this book.

At least one presenter made the case for the difficulty of writing educationally sound software. Why are these presentations always given by someone who works for a company who wants to sell software to the education market? For those who continue to resist the use of microcomputers in education, you are well advised to look for presentations on the high cost of software development. You are almost certain to see statistics that suggest writing a program will require a school district referendum to

Walter Koetke, Putnam/Northern Westchester BOCES, Yorktown Heights, NY 10598.

allow a new bond issue so the program can be paid for after only a few years of hardship.

If you resist the use of microcomputers in education, be sure you do not attend presentations such as that made by CUE (Computer Using Educators). This user group offers hundreds of tested, evaluated, teacher-developed programs for virtually nothing. They will trade you their disk full of programs for your single original program or sell you any of their many disks for $10 each. Efforts such as theirs deserve applause and support, and I hope similar cooperatives will be established elsewhere. You can obtain additional information about CUE by writing them in care of Don McKell, Independence High School, 1776 Education Park Drive, San Jose, CA 95133.

If AEDS were to give an award for bravery, my nomination would be the presenter of a section that defended the recent acquisition of a mainframe time-sharing system rather than microcomputers for an instructional environment. Certainly there are a few advantages inherent in the larger system, but there are also a surprisingly large number of disadvantages. Most important, however, is the need for educators to not view microcomputers or time-sharing systems as an either/or choice. The days of doing everything with one computer or accessing computing facilities in only one way were once very real, but they are now no more than a page in the history of computing.

Earl Joseph, a futurist with Sperry-Univac, gave presentations that were both very enlightening and more than a little frightening. Be sure to hear this man should you ever see his name on a program. As he speaks of the latest technological developments permitting the production of "teachers on a chip" and then "schools on a wafer," he has to have the best view in the house as he can see the faces of the audience. Some of the audience appear to be in shock, some search desperately for a flaw in his reasoning, some see new hope for the future and eagerly take notes, and some just cross their fingers and count the years until their retirement.

While his scenarios mean many different things to the audience, I hear him describing the world in which today's elementary and even secondary students must not just survive, but in which they must compete, make a living and raise a family. Their environment will be quite different from ours, and extraordinarily different from that which exists in our schools. I hear Earl Joseph and I hear a plea that we educate today's students so they are able to deal with the very different world that will be their future.

AEDS also included several presentations on the administrative applications of computers. As with topics on instructional computing, you could easily find the full range of opinions being presented. There were several who advocated that microcomputers can do nearly all administrative tasks, and there were a few suggesting that the microcomputer is inappropriate for any but the most trivial administrative support.

Noteworthy was the fact that all presenters who spoke of microcomputers spoke of very small hardware configurations—those that could be purchased for $3000 or less. Notably absent were discussions of applications being developed for machines in the $6000 to $10,000 range. I find this peculiar, for some of the machines in this price range are capable of doing all of the administrative processing for any school district containing less than 10,000 pupils.

Vendor displays at the AEDS meeting were, as is often the case, more interesting between the booths than in front of them. Most striking was the fact that there was no new hardware and only one piece of new software displayed at the meeting. Also notable was the absence of any mid- to upper-priced microcomputer configurations.

The single new piece of software displayed was Texas Instruments' Logo package. Although prototypes have been occasionally seen for some time, the Logo package is finally available to all of us. I consider this a major step forward in the application of computer technology to instruction, and certainly a feather in the cap of TI as they've taken a nontrivial monetary risk in supporting this step. The generally poor reviews of the TI 99/4 microcomputer are well known and well founded. However, if you accept the premise that the price of a microcomputer can be justified by a single significant application, then the TI 99/4 should find many new homes as a Logo machine. When used exclusively as a Logo machine with students, virtually all of the objections on which the poor reviews were based become invalid.

Perhaps my own career in education gives me a distorted view of the importance of preparation and homework, but I find it increasingly difficult to be polite to vendors who have no idea whatsoever about the status, purpose or even mechanics of using their companies' products. The vendor displays at AEDS were typical in this regard. While I readily acknowledge the presence of some well-informed, helpful vendors, I was told, "I don't know how to load a disk," "Don't ask me, I never saw this program before," "I don't know anything about the books we sell either," "The company never tells us anything," "If the catalog says so I guess it's true" and other similar bits of nonsense far too often. Considering the high cost of booth space, salaries and expenses that the vendors must support, they really ought to make the additional effort to put some knowledge behind the smile that greets you when you see their display.

Keynote Speech

Lou Wangberg, the Lieutenant Governor of Minnesota, was the keynote speaker at the AEDS convention. He delineated several problems and promises of computers in education from a position of understanding. He certainly left the audience wishing that their own state and local politicians could be as well informed and supportive. Little wonder that Minnesota leads the country in the application of computers to instruction.

Wangberg's presentation developed the idea that one of the three characteristics unique to our country is the concept that all children have a right to education rather than reserving education as a privilege for some. Education has also been our country's "great leveler" in that we treat some skills as essential for all citizens. He expressed some concern that computers will "mess-up" this minimum right by being provided for some but not all students. He then discussed the necessity of providing all students with access to computers as part of their public school instruction.

This concern for the haves and have-nots regarding access to computers is certainly a valid one, and one that others have discussed using different scenarios. The small business without computer support is not likely to survive in a world where the competition has computer support. Homes with computer access will provide a different learning, employment and recreational environment to family members than is possible for those without such access. While I share the concern for the have-nots in education and enthusiastically support providing all students with access to computers for instruction, I suggest we must be aware of yet another situation with unclear social consequences.

When nearly all students do gain access to computers, the individualization then possible will highlight the differences between students. The very bright students will proceed at a pace that far exceeds what they can now do. If true individualization of instruction is possible, then providing such instruction will enhance and strengthen the differences between individuals rather than reduce them, as has been the tradition of public education. I suggest this possibility as neither advocate nor opponent, but as one concerned with the social implications of the result.

The AEDS annual meeting did indeed have something for everyone. You weren't alone no matter what your perspective or experience. You could find others in similar situations, and presentations aimed directly at you. The 1982 AEDS annual meeting is in Orlando, Florida, on May 10-14. For more information about this meeting or AEDS, write them at 1201 16th Street NW, Washington, DC 20036. □

By Frank J. Derfler, Jr.

A Modem With Smarts

DataComm Represented At NCC

Disconnect that modem and put down that phone! This month, you and I are going to visit the National Computer Conference in Chicago. While we're there, we're going to see the newest things in data communications, including the revolutionary Hayes Stack Smartmodem, a way to make our terminals talk and a device to connect 16 remote users to a TRS-80 Model II over telephone lines.

The Scene

McCormick Place is a huge convention hall on Chicago's lakefront. The wind is always blowing, but even without the wind, the place was a storm of activity. The floor displays took up three large halls. The displays included music, singers, movies and lots of color, hardware, talking and walking. It was impossible to see the whole show in one day, even if you stopped for only a moment at every interesting display.

The C. Itoh X-100 breaks the pattern by using an M6809 CPU. C. Itoh was particularly interested in finding U.S. distributors who would use their system in special applications. This company has been succcessful with a low-price daisy-wheel printer. Their new bit-mapping graphics printer did a good job of taking a picture right off the screen.

The NCC display floor combines the microcomputer industry and the big computer industry and ignores the difference. Apple and Atari were just down the aisle from Xerox and IBM. Judging from the offerings of both the micro and maxi manufacturers, it is going to become harder and harder to tell the difference. The micro people are coming on strong with hard disks and networking systems, and the maxi folks are marketing desktop work stations with specifications that include dual minifloppies, 64K of memory and compatibility with the CP/M operating system.

Companies represented include Apple and Cromemco, both with interesting displays. The Atari booth was always crowded. They had many people from the Atari product and development staff demonstrating the Atari 800 in many different uses.

Ohio Scientific announced its new integrated business network, IBS-NET, which is a distributed processing network that can interconnect most of OSI's computer systems. Future plans call for the IBS-NET to interface with other local networks such as Ethernet.

The IF-800 from OKI Electric Industry Company is an integrated system with a beautiful color display, full keyboard and Z-80A able to run under CP/M. The standard system includes the double-sided double-density drives, color monitor and an 80-column printer with graphics capability. Options include a ROM cartridge interface and a light pen. The total system, fully loaded, will retail for about $8000.

The Hayes Stack Smartmodem shown alone on the left and with its matching clock on the right. This unique modem contains its own microprocessor and needs no special software or bus structure to perform automatic dialing and answering functions. Seems to be a lot of room in that clock cabinet!

NEW! TPM* for TRS-80 Model II
NEW! System/6 Package
Computer Design Labs

Z80* Disk Software

We have acquired the rights to all TDL software (& hardware). TDL software has long had the reputation of being the best in the industry. Computer Design Labs will continue to maintain, evolve and add to this superior line of quality software.
— Carl Galletti and Roger Amidon, owners.

Software with Manual/Manual Alone

All of the software below is available on any of the following media for operation with a Z80 CPU using the CP/M* or similar type disk operating system (such as our own TPM*).

for TRS-80* CP/M (Model I or II)
for 8" CP/M (soft sectored single density)
for 5¼" CP/M (soft sectored single density)
for 5¼" North Star CP/M (single density)
for 5¼" North Star CP/M (double density)

BASIC I

A powerful and fast Z80 Basic interpreter with EDIT, RENUMBER, TRACE, PRINT USING, assembly language subroutine CALL, LOADGO for "chaining", COPY to move text, EXCHANGE, KILL, LINE INPUT, error intercept, sequential file handling in both ASCII and binary formats, and much, much more. It runs in a little over 12 K. An excellent choice for games since the precision was limited to 7 digits in order to make it one of the fastest around. $49.95/$15.

BASIC II

Basic I but with 12 digit precision to make its power available to the business world with only a slight sacrifice in speed. Still runs faster than most other Basics (even those with much less precision). $99.95/$15.

BUSINESS BASIC

The most powerful Basic for business applications. It adds to Basic II with random or sequential disk files in either fixed or variable record lengths, simultaneous access to multiple disk files, PRIVACY command to prohibit user access to source code, global editing, added math functions, and disk file maintenance capability without leaving Basic (list, rename, or delete). $179.95/$25.

ZEDIT

A character oriented text editor with 26 commands and "macro" capability for stringing multiple commands together. Included are a complete array of character move, add, delete, and display function. $49.95./$15.

ZTEL

Z80 Text Editing Language - Not just a text editor. Actually a language which allows you to edit text and also write, save, and recall programs which manipulate text. Commands include conditional branching, subroutine calls, iteration, block move, expression evaluation, and much more. Contains 36 value registers and 10 text registers. Be creative! Manipulate text with commands you write using Ztel. $79.95/$25.

TOP

A Z80 Text Output Processor which will do text formatting for manuals, documents, and other word processing jobs. Works with any text editor. Does *justification, page numbering* and headings, spacing, centering, and much more! $79.95/$25.

MACRO I

A macro assembler which will generate relocateable or absolute code for the 8080 or Z80 using standard Intel mnemonics plus TDL/Z80 extensions. Functions include 14 conditionals, 16 listing controls, 54 pseudo-ops, 11 arithmetic/logical operations, local and global symbols, chaining files, linking capability with optional linker, and recursive/reiterative macros. This assembler is so powerful you'll think it is doing all the work for you. It actually makes assembly language programming much less of an effort and more creative. $79.95/$20.

MACRO II

Expands upon Macro I's linking capability (which is useful but somewhat limited) thereby being able to take full advantage of the optional Linker. Also a time and date function has been added and the listing capability improved. $99.95/$25.

LINKER

How many times have you written the same subroutine in each new program? Top notch professional programmers compile a library of these subroutines and use a Linker to tie them together at assembly time. Development time is thus drastically reduced and becomes comparable to writing in a high level language but with all the speed of assembly language. So, get the new CDL Linker and start writing programs in a fraction of the time it took before. Linker is compatible with Macro I & II as well as TDL/Xitan assemblers version 2.0 or later. $79.95/$20.

DEBUG I

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TPM*

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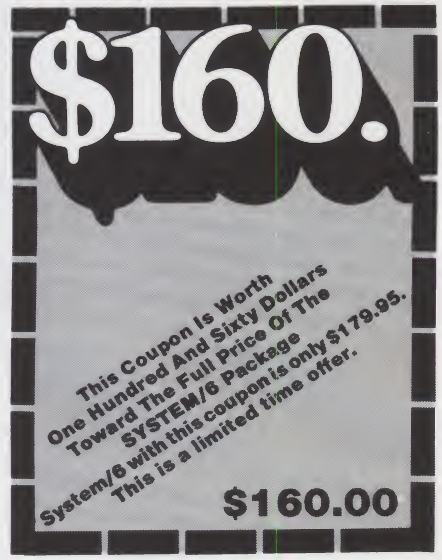

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~See List of Advertisers on page 194

Dominique Smith and Matthew Smith represented Instant Software, Microcomputing *and* 80 Microcomputing. *By the way, in case you are one of those who "inspected" an Instant Software program from the rack and then just walked away with it, don't send it back as defective—you got just what you deserve. The display tapes are all blank.*

Adam Osborne (left) was on hand to discuss his Osborne I system. This dual-drive $1795 unit could blow the competition out of the water, or the small screen could make it fall flat. Initial evidence is that it will be a success. Osborne says he is backlogged with orders through at least the middle of 1982. A straw poll conducted while standing in various lines showed a lot of enthusiasm for the system, "even if you have to use a bigger monitor in some applications." The disk capacity (102K each) seemed small to some people, but most felt that even if they upgraded to higher capacity disks the system would still be very attractively priced.

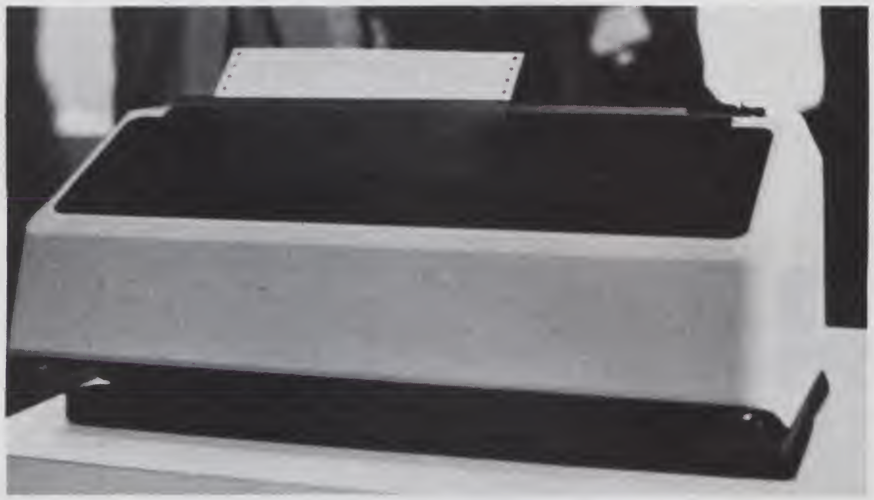
North Star Computers drew a lot of interest with their multi-user system allowing up to five users to share the same system and hard disk. They also introduced an N Series of disk drives providing .82 megabytes of formatted storage per double-sided drive.

Impressions

Three things were apparent. First was the international nature of the show. Many of the attendees were from Germany, France or Japan. The aisles were a babble of languages and sound. There were many Japanese exhibitors, most of whom had complete hardware systems, but needed distributors. This year and the next will certainly see the big Japanese marketing push, but the Japanese systems may bear many different nameplates when they hit the U.S. markets.

The second impression was that voice synthesis has come of age. Electronic voices were calling from several booths.

Finally, there will certainly be a little color in your life sometime soon. Color displays were numerous on new systems, and lower-cost color printers seem to be emerging. The accompanying photos will give you many of the details of the displays, but this is a column on data communications, so let's see what the communicator can use.



Integral Data Systems demonstrated their very nice color printer. This device uses a multi-color ribbon which produces excellent quality. Release? "Maybe Christmas." Price? "Maybe $2000, maybe a little more."

Smartmodem

It all started with a company called D. C. Hayes making internal modems for Apple II and S-100 bus systems. They have changed their name to Hayes Microcomputer Products, Inc., but they still make the same integral modems. Now, they are launching a new product line of unique smart peripheral devices capable of interfacing with any computer system. The first ship of the line is the Smartmodem, and she's a beauty (see photo).

The Smartmodem is an RS-232C device. It is not a bus decoding or integral system. It does, however, provide all of the features of an integral modem (auto dial/answer, etc.) without unique software. In fact, the modem is so smart that the terminal can be completely dumb and still have automatic capability.

A small Z-8 microprocessor in the Smartmodem monitors the ASCII characters coming from the terminal (or microcomputer running a terminal program). It acts as a normal modem, converting the dc signals to audio tones at up to 300 bits per second (bps), until it recog-

The Japanese companies had many systems on display. Often, they were looking for U.S. distributors for their products. Many U.S. system houses will probably market Japanese systems under their own names. NEC was pushing their PC-8000 series system, which features a full-color display, Z-80A 4 MHz CPU with CP/M compatibility and a very nice full-capability keyboard. Note the "IO Unit" expansion interface on the left.

nizes a string of characters pre-set in its memory. This command string can tell the Smartmodem to auto dial and auto answer, or to change such operational parameters as dialing speed, pulse or tone dialing, number of rings to answer on, originate/answer mode and local echo. The modem will accept the command and send you back a prestored acknowledgement.

In normal operation, the Smartmodem comes up in an initial default mode which is determined by internal switches. You can command the modem to perform any of its functions directly from the keyboard. An easy way to do this would be to use the features of smart terminal programs such as Omniterm, ASCII Express or Smart 80, which can prestore log-on codes of about 40 characters. These "macros" can be automatically sent by the selection of one or two keys and would be perfect for ordering the Smartmodem to auto dial.

Alternatively, a simple BASIC program could be used to shoot the desired characters out the RS-232C port. But I should emphasize that the Smartmodem can work with any dumb terminal. The commands can be quickly and easily entered from the keyboard.

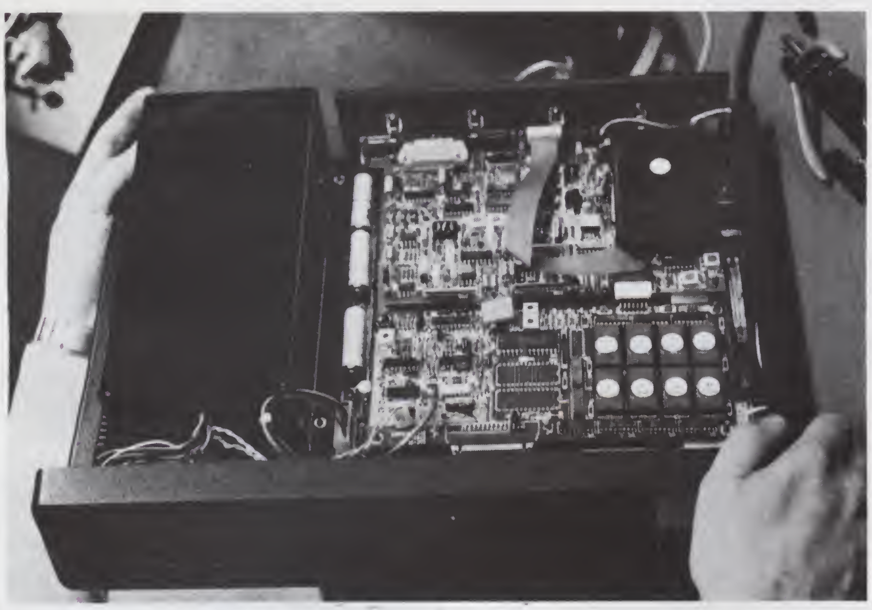
The Smartmodem has a nice operating feature in the form of a built-in speaker, which lets you listen to the phone line. This is particularly useful during the dialing process so you can tell if you were not connected because of a busy signal or an unanswered ring. I usually leave a phone off the hook (with the microphone element removed) when using a direct-connection modem just so I can hear what's going on. I personally like to have the additional sense of hearing involved in the communications exchange—maybe that comes from 25 years of amateur radio operations.

I wonder, though, how much more in the way of smarts would be required for the Smartmodem to differentiate between a busy signal and a ring?

The Smartmodem is only the first of a line of unconventional peripheral devices. The photo shows a digital clock which mounts under the Smartmodem and interfaces with it. It hasn't been officially released yet and no one is saying what the interfaced system will do, but the cabinet is awfully big for just a clock. The Smartmodem should be reaching dealers right about now. The suggested retail price is $279—not bad at all for such a unique and versatile device. Contact Hayes Microcomputer Products, Inc., at 5835 Peachtree Corners East, Norcross, GA 30092.

Talk to Me!

Several months ago, I wrote that the man-machine barrier must be broken.



The Digital Pathways SLC-11 voice synthesizer can store well over 300 complete words in ROM. The 6502 CPU and extensive operating system provides this "smart peripheral" with many options such as a list of different things to "say" to different people in response to one input. The activation of a fire sensor may cause the system to dial the fire department and give the address; it can then announce "Fire!" over the PA system while dialing the company president to tell him to "Get here quick!" The voice quality is excellent. The price is about $2000.

✓See List of Advertisers on page 194

The Votrax Type-'N-Talk is a versatile unit which reads aloud an ASCII string of characters. Words are defined as a string of characters separated by a space. A single letter or number bracketed by spaces will be pronounced by its name. An audio output on the back side of the unit is provided for feeding a more powerful amplifier. RS-232C and power are the only inputs. This smart peripheral devices sells for $345.

Epson America took advantage of the show to introduce their new MX-100 printer, which is essentially an MX-80 with the capability of printing up to 233 columns wide in the compressed mode. It has both pressure feed and removable tractors and includes Epson's Graftrax II graphics package that gives high-resolution bit image graphics. Retail price is under $995. A pressure feed version of the MX-80 was also on display. That's Chris Rutkowski, marketing manager of Epson, about to get his finger stuck in the printhead.

We have to develop terminal devices that are more user-friendly and less dependent on CRT displays and typing skills. The first cracks in the man-machine barrier have appeared. The NCC featured several voice synthesis and voice recognition systems.

The highest-quality speech came from a system produced by Digital Pathways (see photo); it had complete words stored in ROM for the use of the synthesizer. But at nearly $2000 in single-unit quantities, this device is aimed at commercial uses (such as electronic banking).

The hit of the show was a small $345 unit from Votrax called Type-'N-Talk (see photo). The name says it all. The Type-'N-Talk reads ASCII code coming from an RS-232C port and pronounces the English phonemes together to make words. The Type-'N-Talk needs no special program running in a computer. It has its own internal 6800 microprocessor and simply reads aloud the ASCII stream. It can be connected to any source of ASCII characters using RS-232C signaling. The price and ease of use make it almost a toy that you can keep around the computer room just to impress visitors if you do nothing else with it.

Of course, other things can be done with such an easy-to-use speech synthesizer. It is perfect for computer-assisted instruction. The verbal feedback it can provide in a training situation is unmatched by anything that can be easily put on a CRT. It has valuable uses for the blind, though some of these uses can be limited by the simple throughput speed of human speech.

The synthesizer operates from 70 to 100 bps. This roughly equals two words a second or 120 a minute (an average of five bytes per word). The unit has some buffering and can accept the data at any standard rate up to 9600 bps, but it can only pronounce it at about 120 words a minute. If you overload the 750 character buffer, you will simply lose the data.

This device could be used by the blind to read articles or mail from information utilities like The Source and CompuServe if the information utilities were instructed to transmit short "pages" (perhaps

The folks at Personal Software kept the crowds happy with a constant demonstration of their VisiCalc and other "Visi-" software.

A communications multiplexer that can combine 16 phone lines to connect to and share the services of a TRS-80 Model II.

The quality and clarity of the Type-'N-Talk voice take a few minutes to get used to.

ten lines of 60 characters). A page is not transmitted until a carriage return acknowledges that the receiver is ready. This would, however, greatly slow down the rate of data exchange and greatly increase the connect time charges.

Alternatively, this device could be used to read information utility files if the data was downloaded at full speed, stored in local files by a smart terminal program and later retransmitted out the RS-232C port at a slower baud rate.

The Type-'N-Talk is beautifully set up to do this kind of modem-to-talker switching because it has a built-in extension of the RS-232C line. You do not have to change connectors or have two different RS-232C ports.

The quality and clarity of the Type-'N-Talk voice take a few minutes to get used to. The device has a frequency control which actually lets you fine-tune the pitch of the voice to your ear, and that helps. After about three minutes of listening, I didn't miss a word. It is very much like listening to someone with an accent. The machine speaks phonetically, not colloquially. You get used to the rhythm and phrasing quickly, but you might not want to hit someone cold with it; say, over a telephone. It is not as good (or expensive) as the complete word synthesis systems used by the telephone company and banking services. But those systems are limited to about 300 words in ROM. Type-'N-Talk has no limitation. It can string together phonemes for anything you can type. Quite a machine! Phone Votrax at 1-800-521-1350 to order one.

Together?

The Hayes Stack Smartmodem and the Votrax Type-'N-Talk both represent a new breed of intelligent peripherals containing their own microprocessors and operating programs. They need no unique software to operate. I wonder if you put the two devices on line together, would the Smartmodem read its command string and reply back through the Type-'N-Talk, "By Your Command"? The modem could tell you when the phone was ringing ("One ringy-dingy, two ringy-dingy"). It could tell you when it had a carrier ("The tone! The tone!"). The list is endless. Mr. Hayes, there was a lot of room in that clock cabinet!

16 to 1

What was that big box sitting next to the TRS-80 in the above photo? Simple—it's a communications multiplexer.

A communications multiplexer is a device that combines many communications channels into one. Let's say, for instance, that you wanted to combine about 16 phone lines together so they could connect to and share the services of a TRS-80 Model II. Perhaps you wanted to set up a private information network for a company or development team, or groups of geographically separated farmers, doctors or librarians. Perhaps you were not happy with the one-at-a-time service most systems provide. You could then use a communications multiplexer to answer and combine as many as 16 phone lines into one.

The unit on display at NCC was an engineering model just fresh from the FCC certification labs, but a production unit should be appearing soon. You had better be serious though. The price for the 16-port unit was said to hover about $8000. Oh, by the way, this kind of multitasking is very difficult to do if you don't have a hard disk.

Tell me

The world of microcomputer-based data communications systems is moving quickly. The power of its software and the quality of the hardware is maturing. If you market or manufacture hardware or software of interest to data communicators, let me know. Drop paper mail to PO Box 691, Herndon, VA 22070, and include a stamped envelope if you want a reply. Send electronic mail to TCB967 on The Source, 70003,455 on CompuServe, or to the AMRAD CBBS (703) 734-1387.□

Sony's 3-1/2-inch microfloppy drew a lot of attention. The 3-1/2-inch device can provide 435K of storage, but it isn't cheap.

By Eric Maloney

Name That Data Service

You Can't "Tele-text" Without a Scorecard

Videotex? Videotext? Viewdata? Teletext? The increased interest in information retrieval systems has caused some confusion as to what term refers to what service. The definitions are used somewhat interchangeably by many people, but for the sake of clarity, *Microcomputing* has settled upon the following:

Videotext is a generic term that refers to the transmission of textual material via telephone lines or TV signals to your TV set or microcomputer. It thus encompasses both viewdata and teletext.

Videotex is commonly used in place of videotext, particularly in Canada, which recently hosted the Videotex '81 conference. But it also refers to a specific information retrieval system being marketed by Radio Shack. The full system consists of a TRS-80 Videotex terminal and Videotex software. (To show how confusing this can get, the October 1980 issue of Radio Shack's *TRS-80 Microcomputer News* refers to the software as Videotext in the headline and Videotex in the text.)

Teletext, according to the book *Videotext: The Coming Revolution in Home/Office Information Retrieval*, is "a one-way system, which piggybacks digital data on the normal television broadcast signal by inserting its messages in unused lines of the vertical interval." The user is able to call desired pages with a special control keypad.

Viewdata, says the same book, is an interactive system using the telephone lines and a modem. This shouldn't be confused with the Viewdata Corp. of America, which is a subsidiary of Knight-Ridder Corp.

* * * * *

A postscript to last month's comments on acronyms:

Keith Alexander of Detroit points out that many computerists are getting in the habit of capitalizing the language Ada, as in ADA. But Ada, like Pascal, is the name of a person, and is not an acronym. Ada Augusta Lovelace was a mathematician, and an associate of Charles Babbage, a 19th century inventor.

Alexander also says that the word spool, when referring to timesharing tasks, is an acronym for Simultaneous Peripheral Output On Line. It's a good example of an acronym falling into common use as a word.

* * * * *

In June, this column offered a simple formula by which business executives could name new products and companies. It consisted of two lists—26 pre-

```
10 'COMPNAME - PROGRAM TO INVENT COMPANY & PRODUCT NAMES
15 'BY JEROME S. MILLER, GRAND RAPIDS, MI 49505
20 'SUGGESTED BY ARTICLE IN KILOBAUD, JUNE '81, P. 24
25 'BASED ON ALIEN NAME PROG. PERS. COMP. MAG. 11/'79 P. 56
30 'THIS LISTING IS FOR TRS-80 MOD I TRSDOS 2.3
40 'DELETE LPRINTS IF YOU DON'T NEED HARDCOPY
100 DIMA$(26),B$(26)
110 A$(1)="COMPU":A$(2)="TELE":A$(3)="MULTI":A$(4)="DATA"
120 A$(5)="INTER":A$(6)="DIGI":A$(7)="AUTO":A$(8)="UNI"
130 A$(9)="VIDEO":A$(10)="INFO":A$(11)="SOFT":A$(11)="MEGA"
140 A$(12)="ASTRO":A$(13)="MICRO":A$(15)="OPTI":A$(16)="DYNA"
150 A$(17)="PLEXI":A$(18)="RAM":A$(19)="COM":A$(20)="TECHNO"
160 A$(21)="CON":A$(22)="FILE":A$(23)="INSTA":A$(24)="META"
170 A$(25)="ELECTRO":A$(26)="ALPHA"
200 B$(1)="DATA":B$(2)="SOFT":B$(3)="MICRO":B$(4)="RAM"
210 B$(5)="NET":B$(6)="COM":B$(7)="TYPE":B$(8)="TECH"
220 B$(9)="MATION":B$(10)="WRITER":B$(11)="GRAPHICS"
230.B$(12)="TEX":B$(13)="SERVE":B$(14)="FAX":B$(15)="TEL"
240 B$(16)="TRONIX":B$(17)="PLUS":B$(18)="CON":B$(19)="FILE"
250 B$(20)="FLEX":B$(21)="COMP":B$(22)="FLEX":B$(23)="VIDEO"
260 B$(24)="LINK":B$(25)="METRICS":B$(26)="CALC"
300 CLS:PRINTTAB(12),"<*> COMPANY & PRODUCT NAMES <*>"
305 LPRINTCHR$(32):LPRINTTAB(12),"<*> COMPANY & PRODUCT NAMES <*>"
310 PRINT
320 INPUT"HOW MANY NAMES DO YOU WANT";N
325 LPRINTCHR$(32):LPRINT"HOW MANY NAMES DO YOU WANT";N
330 CLS:PRINT"HERE ARE YOUR"N"NAMES":PRINT
335 LPRINTCHR$(32):LPRINT"HERE ARE YOUR";N;"NAMES"
340 FOR I=1 TO N
350 GOSUB1000
360 X$(1)=A$(A)   'SELECT PREFIX
370 GOSUB1000
380 X$(2)=B$(B)   'SELECT SUFFIX
390 PRINT X$(1)+X$(2):LPRINT X$(1)+X$(2)
400 FORT=1TO100:NEXT
410 NEXT I
500 PRINT"TYPE 1 FOR NEW LIST; 2 TO EXIT"
510 Z$=INKEY$:Z=VAL(Z$)
520 ONZGOTO 300,540
530 GOTO 510
540 CLS:PRINT@464,"BYE BYE, COME BACK AGAIN!"
550 END
1000 A=RND(26):B=RND(26):RETURN
```

Listing 1.

fixes and 26 suffixes—which could be randomly combined to make 676 possible monikers. Well, Jerome S. Miller of Grand Rapids, MI, wrote a program for the TRS-80 Model I that does the pairing automatically. Listing 1 is the program, while Sample run 1 gives 40 of the possible combinations.

* * * * *

Is-this-what-you-really-wanted-to-say department: Microcomputing author Mark Borgerson, who makes his home in Corvallis, OR, was looking through the software notes for Hewlett-Packard's HP-85 when he ran across this mind-twister.

"This particular note concerned problems which might occur when users tried to run certain application packs with other ROMs plugged into the system. It seems that the ROM packs compete for memory, resulting in an Out of Memory error. The software note explained the problem this way:

" 'The pacs were designed to operate in a particular "typical configuration" so that more power could be built into each application. This trade-off in power versus flexible configuration was deliberately made to minimize the capabilities of our software for the most number of users.'

"Somehow, I think the marketing people at Hewlett-Packard might object to the phrasing in that last sentence."

* * * * *

Punctuation is a boogeyman for many writers. Some have an almost complete aversion to it, while others toss punctuation marks around like grass seed. In this latter category are the comma fetishists, who can't march across a typed line without dropping two or three commas along the way. Reading their sentences is like climbing a tall ladder—by the time you reach the top, you're so exhausted that you're no longer interested in the view. Here's an example that recently crossed the *Microcomputing* desk:

"Quite simply, Grow is a BASIC language program, currently available to Apple II and Plus II and North Star users, that allows you to write, in plain English, and with only a few system commands, original, one-of-a-kind programs, which are contained in nodes, mini-programs themselves, linked together as needed to make up the entire program."

Is this any way to treat the comma?□

```
<*> COMPANY & PRODUCT NAMES <*>

HOW MANY NAMES DO YOU WANT 40

HERE ARE YOUR 40 NAMES
TECHNOFAX
TELETEL
PLEXIMETRICS
DATACOM
PLEXIRAM
DATACOMP
INSTATEL
AUTOFILE
DYNAMETRICS
PLEXISERVE
RAMLINK
COMSOFT
TELECOM
INSTAFAX
INFOTEL
CONTEX
DIGIVIDEO
ALPHAFAX
METALINK
INFOMETRICS
METAPLUS
TECHNOMETRICS
DATALINK
AUTOTECH
CONLINK
FILEFLEX
DYNASERVE
FILECALC
VIDEOLINK
MICRORAM
RAM
INFOMATION
PLEXITEL
INSTASERVE
METATYPE
FILETECH
DYNAPLUS
FILETYPE
DYNAVIDEO
INSTAPLUS
```

Sample run 1.

 Compiled by Eric Maloney

Micro M. D.

Data for Health

An Apple software package that will make health information easily accessible to both doctors and their patients is being tested in several Montreal clinics.

Over a dozen programs will provide preventive and treatment information on such topics as chronic diseases and the side effects of medication and general health tips.

The package, developed by Dr. Michel Bourque of Montreal's Clinical Research Institute, is designed for a $3000 Apple II with one disk drive and 48K memory. Bourque uses Applesoft BASIC with DOS 2.3, and has a numeric keyboard from Advanced Business Technology.

The programs, in a question/answer format, are for the "naive user," Bourque says. "We kept it very simple, so it can be used without training." The patient chooses a disk with the desired topic. The computer records the patient's questions, so the doctors can change the database according to demand. The computer can also question the user to help doctors develop demographic data.

The database has been compiled by five doctors at the institute's Hypertension Clinic, and at a research clinic headed by Dr. Robert Perrault of Montreal's Prevost Hospital.

Perrault is now testing programs that will provide sex education and contraceptive information for adolescent patients. The microcomputer is set up in a waiting room; Perrault hopes it will encourage patients to ask doctors further questions. The Hypertension Clinic is also using the micro, and its stress program is being tested throughout Quebec.

Another program, to help the chronically ill cope with the secondary effects of disease, will be tested in late fall, Perrault says. Three groups will be given diet and treatment advice: one with the microcomputer, another by a specialist and the third through biblio-therapy, or reading material. The hospital has few people for one-to-one counseling, Perrault says, and the computer should help to ease the pressure.

Though the system is suitable for both clinics and private practitioners, Bourque says it can also be used in such public places as shopping malls. Private physicians will find the system useful for after-hours business. And with additional software, it could even be converted to a computer bulletin board for doctors and researchers.

The $100 operating disk and $30 database are available from the institute's Computer and Biostatics Research Centre, 110 Pine Ave. W., Montreal, PQ H2W 1R7.

Contributed by Betty Thayer, *Microcomputing* staff.

Is There A Computer In the House?

Down on the Farm

The growing number of farmers using microcomputers has spawned a new newsletter—*Farm Computer News.*

The newsletter, spun off from Meredith Corp.'s *Successful Farming* magazine, made its debut in May, promising "all kinds of computer information of interest to farmers, farm managers and agribusiness people."

The idea for the magazine came after a survey showed that at least one percent of *Successful Farming's* 750,000 subscribers own computers, with another 23 percent expecting to buy one within six years.

Most of those computers are TRS-80s, Apples and Commodores.

The first issue of *FCN* included an article on a users group called Agri-Cursors, a review of the Microsoft Z-80 card, a piece on information retrieval, tips for computer buying and the Computer Trade Mart.

Editors Chuck Sommers and Gary Vincent have an Apple II+ in the office. While they don't do any word processing on it, they use the Apple for reviewing programs and accessing outside databases.

"The unit we bought is very typical of what the farmer has," says Sommers. "This way we put ourselves in their position."

He adds that neither he nor Vincent is a "computer expert," although he has taken some computer courses at a local community college. But he says that this will let them walk through the same problems that their readers are experiencing.

While Radio Shack has actively pursued the agriculture market, Sommers says that Apple dealers "follow their sales more than Radio Shack."

"Radio Shack said basically, 'Here it is; take it or leave it,' " Sommers says. "They knew what we wanted and that we were very interested, but they didn't follow up on it."

Most farmers are using their computers for basic business management and accounting applications, Sommers says. The software is coming from a number of places: software houses, universities, independent consultants

and the farmers themselves. Except for financial needs, says Sommers, most farming applications are too specific for general off-the-shelf programs.

"VisiCalc has been adapted because there hasn't been anything else," he says. "It adapts well, but it is by no means the final answer."

Some farmers are using their micros to access such information databases as Agnet, which provides programs that farmers can use on their own systems. Other services, such as that of the Green Thumb project in Kentucky, offer information on such topics as market, the weather and pest control. But Sommers says that some kinks still have to be worked out before farmers make widespread use of these services.

"I know a farmer who's trying to use CompuServe, and is finding that it's not fast enough," he says. "He can get his information faster on the radio."

Subscriptions to Farm Computer News *are $40 per year. For more information, write to them at 1716 Locust, Des Moines, IA 50336.*

Jerry Van Dyke, Where Are You?

You'll never have to look at your automobile's idiot lights again with Copilot, a microcomputer that monitors the car's systems and tells you over the radio when any of them are malfunctioning.

The soft, female voice—which should bring a rush of nostalgia to those who fondly remember Ann Southern and "My Mother the Car"—prompts you with such gentle hints as "Please remember your lights" and "Please remember your keys." It also lets you know when:

- The door is not closed tightly.
- You're almost out of gas.
- Your brakes are about to fail.
- Your oil pressure is low.
- *The lights are left on* after the engine is turned off.
- The engine is about to overheat.
- The keys are left in the ignition.
- The seat belts are left unfastened.
- The battery voltage is low.
- Diesel engines are not warmed up.

Copilot is the creation of Aristotle, Inc., owned by brothers John Aristotle and Dean Phillips. J. A. also goes by the alias The A-Bomb Kid—he's the Princeton University student of several years ago who made news by designing an atomic bomb from public documents. He's now 25, while his brother, an MIT graduate, is 23.

Dean says the Copilot is essentially a verbal set of idiot lights. The unit taps into the wires that run to the various lights and buzzers in the dash. Each unit, while not programmable by the owner, has what Phillips calls "a certain amount of learning ability," which lets the owner adapt it to his particular make of car.

With the exception of fuel, the critical levels at which Copilot responds are predetermined. The owner can adjust the computer to warn him or her of low fuel at anywhere from empty to half a tank. The voice will pipe up whether the radio is on or off.

Why a female voice? "It was a very conscious decision on our part," Phillips says. "The noise in a car tends to be low-frequency, and a male voice literally gets lost. Also, we felt that a female voice was more pleasing to hear."

Phillips says that Copilot is made to fit all cars. "If it comes out of Detroit and uses standard engine technology, it can use our system." It is also usable by trucks, buses and most other types of vehicles.

The company claims that Copilot is a first in the industry. Datsun has a model that talks, but, says Phillips, they use "what is literally a small record player." General Motors uses a microprocessor in some of its Cadillacs, but it does not have voice capability (see next article).

> The soft, female voice prompts you with such gentle hints as "Please remember your lights" and "Please remember your keys."

"Many automobile manufacturers didn't think that voice was possible for at least a couple of years, so they didn't bother with it," Phillips says.

By the way, if you're a hardware tinkerer thinking of buying one to modify for other uses, Phillips warns against it. The unit uses National Semiconductor's Digitalker DT1050 integrated circuit set, but uses special operating software and a custom-designed vocabulary.

The Digitalker kit is available commercially, and includes a vocabulary of 144 expressions. For a complete discussion of the kit, see Steve Ciarcia's article "Build a Low-Cost Speech-Synthesizer Interface," on page 46 of *Byte* magazine's June 1981 issue.

Copilot sells for $199.95 plus $4.50 for postage and handling. For more information, write Aristotle, Inc., Box 21, Norwalk, CT 06853. If you want to buy one, you need to include the make, model and year of your car.

Cadillac Blues

The microprocessor-controlled 1981 Cadillacs are beaching like suicidal whales, according to an article in *Electronic Engineering Times.*

In fact, some 100 Cadillac owners in 22 states have filed a class-action suit against General Motors, complaining of such problems as stalling in traffic, poor fuel economy, engine surges and indecisive shifting.

The Cadillac was introduced with much fanfare because of its unique 4-6-8 cylinder mechanism, which uses a microprocessor to find the right cylinder operation according to the driving circumstances.

An interesting feature of the microcomputer, says *EET*, is that it records whether the driver goes over 85 mph. The computer will also record whether the owner receives proper service within 30 miles of driving after the Check Engine light goes on.

Time for Beddy-Bytes

Homestead Computer Services, Ltd., of Winnipeg, Manitoba, has designed a computerized hospital bed monitoring system for Winnipeg's Seven Oaks Hospital.

Admissions/discharge/transfer (ADT) systems have often tied into large computers to keep track of patient bed use, but this is the first microcomputer-based bed monitoring system, says Homestead's president Sheldon Fulton.

The system's speed will let the hospital use its bed space more efficiently, saving both the hospital and Canadian taxpayers money.

The system, in use since Seven Oaks opened in January 1981, consists of a modified Vector Graphics microcomputer and five G.E. ADS terminals. Current patient-status information is stored on memory boards which have battery backup in case of power failure.

A terminal is located at nursing stations on each of the three floors where information can be quickly accessed and updated for that floor. Another terminal, centrally located at the admitting desk, can access and update information for the entire hospital. A fifth terminal, located in housekeeping, has display capabilities only.

Information provided by the computer includes bed status (occupied or empty), whether the room is for men or women, which wing of the hospital the room is in, when the room needs to be cleaned and when it's available for admission.

Florence Landygo, director of health records and information services at Seven Oaks, has found the system helpful and easy to use. Speed of information communication and reduced paper flow are two of the advantages of the new micro system. "By and large it does its job," Landygo says. Two modifications she recommends are inclusion of the patient's name with the other data dis-

played on the screen and printout capability.

Although it's too early to tell how much money Seven Oaks has saved through microcomputer-based bed monitoring, Homestead Computer Services is optimistic about the success of such systems. Says Fulton, "We're interested in seeing where we can go from here."

Contributed by Lise Markus, *Microcomputing* staff.

Publications on Courseware

Several new publications focusing on courseware are out, or will soon be available.

School MicroWare Reviews will make its debut in July, and will feature reviews for some 100 instructional programs and packages. The publication, which will come out twice a year, will be organized by school department and subject. A rating of each software package will be accompanied by comments on documentation, instructions to users and the student-computer dialog. Each edition will also include an index to evaluations in other publications.

SMW Reviews will cost $30 per edition. Subscribers to Dresden's other publication, the *School MicroWare Directory*, will receive it free if they submit evaluations to *Reviews*. Nonsubscribers whose reviews are used will receive it for half-price.

Dresden Associates, Inc. is located at PO Box 246, Dresden, ME 04342. Call 207-737-4466 for an evaluation form and instructions.

The 1981 *Courseware Market Report*, published by Shotwell and Associates, is billed as "the first comprehensive reference book for all individuals, companies, and institutions preparing educational products for the computer software market."

The report includes statistics on hardware installations in educational institutions, a discussion of videodisk technology, a listing of hardware and courseware suppliers and a discussion of programming and authoring languages for developing educational software on microcomputers.

Price for the volume is $175.

Shotwell and Associates is located at 44 Montgomery St., Suite 505, San Francisco, CA 94104.

Queue provides several directories of educational software. Their *IVA Educational Software* catalog is for the Apple, Atari and Compucolor, while the *IVB* catalog is for the PET and TRS-80. The *IVB* catalog also includes limited listings for the Sinclair, OSI and SOL micros. The catalogs are $8.95 each.

Queue's address is 5 Chapel Hill Drive, Fairfield, CT 06432.

The National Council of Teachers of Mathematics has recently published a 30-page book entitled *Guidelines for Evaluating Computerized Instructional Materials*. The book, written for both experienced and novice programmers and users, discusses how to find promising materials without first buying them, how to evaluate the software and how to catalog it.

The book's forms and checklists are designed to be computerized for easy use, updating and retrieval.

The *Guidelines* are $3.75, $3 for NCTM members. The Council's address is 1906 Association Drive, Reston, VA 22091 (703-620-9840).

Help Solve a Murder

The quick summary read "Help Solve a Murder!", and many people accessing the Nobug Forum-80 Bulletin Board in Cleveland probably thought that it was from a frustrated game player fishing for clues to an adventure program. But if they retrieved the full message, they were in for a surprise: it was a call for help in tracking down equipment taken from a computer store during a robbery that resulted in the killing of the owners.

The message reported how Henry and Laverne Rumberger, owners of the ABS Computer Services Store in Olympia, WA, were killed on Sunday, Feb. 22. It followed with a list of the equipment stolen, along with serial numbers. The equipment included an Apple III, three Apple IIs, a disk drive, a BMC monitor, a Sony TV, a Centronics 737 and an IDS Paper Tiger.

"If you discover any of these items, please contact the Olympia police department," the message concluded, along with the department's phone number.

Nobug operator Ray Furlong says that he read about the murders in a microcomputer magazine, and thought it was a good idea to put the information on his system. As far as he knows, it's the first time a system has been used for that kind of message.

The idea may be a precursor to more organized attempts to locate stolen equipment. According to a store owner in Seattle, WA, the Seattle-Puget Sound area has had a rash of burglaries during the last year. Dealers are considering forming a dealers association, one function of which would be to exchange information on hot hardware.

"Our service center sees a lot of equipment, and it would be very easy for us to match serial numbers as the stuff comes in," he says.

The "Help Solve a Murder!" message has been picked up from Nobug and put on at least one other system, the Medical Forum-80 BBS in Lansing, MI.

Ancestors on Disk

Genealogical Computing, a bimonthly newsletter for genealogists and computerists, begins publication this month.

The newsletter, put out by Data Transfer Associates, will include a directory of genealogy programs for micros, columns on how to computerize family research records and program reviews.

Editors Paul and Saralou Andereck operate the Family Historians' Forum, a free computer bulletin board system for genealogists. The Forum, which has been on-line since September of 1979, is used to exchange family research information.

Genealogical Computing costs $12. DTA's address is 5102 Pommeroy Drive, Fairfax, VA 22032. Call 703-978-7561 from 6 PM to 6 AM on weekdays and noon to 6 AM on weekends and holidays to access the Forum.

Dow Jones for PETs

The Dow Jones Portfolio Management System, a software package designed for accessing its News/Retrieval Service, is now available for Commodore microcomputers.

The system will run on Commodore's dual disk microcomputer, Model 2001-32K or Model 4032. Buyers will also receive a Dow Jones password and one hour of free introductory usage.

The system, developed by Micro Business Systems of Pine Brook, NJ, is for private and professional investors, letting them maintain multiple portfolios and continuously track, value, graph and research each one. It automatically retrieves price quotations (on a 15-minute delay basis) on some 6000 stocks and other securities from Dow Jones' computerized News/Retrieval Service.

Dow Jones News/Retrieval Service provides business news from Dow Jones' domestic and international news wires, *The Wall Street Journal* and *Barron's National Business and Financial Weekly*, plus company profiles and 10K extracts from Disclosure, Inc., Washington, DC; detailed corporate financial information from Media General Financial Services, Inc., Richmond, Va.; and a weekly economic survey of key economic and monetary indicators, with commentary and analysis, from Money Market Services, Inc., of San Francisco, CA. In addition, Free Text Search allows users to retrieve news stories as far back as June, 1979 by keyword search.□

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Read how this exercise in data storage frugality increases the capacity of your five-inch diskette eightfold.

Firm Up Your Floppy With 800K

By Peter A. Stark

It's quite possible to put 800 kilobytes of data on one five-inch minifloppy diskette, thus rivalling the 1.2 megabytes or so that can be stored on an eight-inch diskette.

The trick is to use one of the newer disk drives such as the model 92 made by Micro Peripherals, Inc. (MPI), which provide twice the number of tracks per side, with two sides, and at double density. Since a normal five-inch diskette can hold slightly over 100K, this multiplies that number by eight for a total of about 800K.

Let's take a look at five-inch floppy disk drives in general, and then the MPI Model 92 in particular.

Floppy Fundamentals

The floppy diskette is a disk of plastic, five inches in diameter, which is coated on both sides with a magnetic oxide coating such as that used on recording tapes.

The disk is enclosed in a rectangular, stiff plastic envelope just a bit larger than the disk itself. The inside of the envelope is covered with a fiber material smooth enough that the disk can rotate within the envelope without being scratched.

In the center of the diskette is a round hole slightly over one inch in diameter; the plastic envelope in turn has a slightly larger hole in the center. When placed into a disk drive, the diskette is grabbed by a metal hub from one side, and a plastic expansion hub from the other; these hubs are centered within the large hole in the center of the disk, and hold the diskette tightly so it can be turned. The disk drive has a small motor, usually operated from a +12 V dc power supply, which turns the metal hub and spindle via a plastic belt. In operation, the diskette turns at five revolutions per second (300 rpm).

The rotating speed must be held quite close to this value; most disk drives have a built-in regulator, possibly with a feedback tachometer on the spindle which helps keep the speed constant. There is usually a set of stroboscopic marks on a flywheel. These marks appear to stand still when viewed in a fluorescent light when the spindle is rotating at the correct speed. The motor speed regulator usually has an adjustment to allow slight changes in speed.

In hard-disk systems the motor is turned on continuously. This is not the case with floppy drives. In fact, most drive manufacturers specify that the motor should be turned off within a second or two after the last use of the drive for maximum life of both the drive and the diskette.

Though this is obviously a good idea, in practice it slows down operation, since there is always a delay of about one second from the time the motor is turned back on to the time the disk can safely be used. Since turning the motor on and off is done by the disk controller, many microcomputer manufacturers leave the motor on for 15 to 30 seconds after each use; some manufacturers leave the motor on continuously.

Data is written on the disk or read back by a read-write head which touches the diskette. (Here is another difference between a floppy disk and a hard disk—in the hard disk the head rides above the disk, and [hopefully] never touches.) The head can reach the disk through a slotted hole in the outer jacket, about a half inch wide by about 1-1/8 inches long.

The head is mounted so it can slide in and out to reach different tracks. A track is a circular path around the disk; when the head is positioned over a track, the turning of the disk continuously rotates the same track under the head. That is, the track on a computer disk is not like the groove on a phonograph record since the groove keeps moving closer and closer to the center of the record as it turns; the disk track is a circle that does not spiral to the center.

The head itself is mounted on a carriage which slides in and out on two or three metal rods. The carriage, in turn, is moved in different ways by different manufacturers. The cheapest and most popular arrangement is to attach the carriage to a stepper motor through either a cam or metal

Peter A. Stark (PO Box 209, Mt. Kisco, NY 10549) writes extensively on 68xx systems for Microcomputing.

band so that the rotary motion of the motor shaft is translated into a straight-line motion of the head carriage.

The shaft of a stepper motor moves in steps in response to an electrical signal. This is quite different from the normal kinds of motors we are familiar with, whose shafts turn smoothly and continuously; the stepper motor turns in discrete steps or jerks. The amount of movement per electrical pulse depends on the mechanical motion of the motor and can be fairly well controlled. In general, the mechanical linkage between motor and head carriage is such that anywhere from one to four motor pulses are required to move the head exactly one track.

There is usually a microswitch mounted within the drive which closes a contact when the head is on track zero. The disk controller thus keeps track of where the head is by first moving the head all the way out until the track zero switch closes, and then keeping a count of pulses as the head is moved into inside tracks. If something else should move the head in the meantime, then the disk controller would think the head was on a different track from the one it is actually at. This is an important concept, and will show up again later.

Another way of moving the head carriage is by a voice coil actuator. This is a technique used more in standard eight-inch floppy drives as well as hard disks. Rather than move the carriage in discrete steps, the voice coil actuator is an electromagnet which can move the head in or out in one continuous motion. By use of a feedback loop and a servo system, this system controls carriage speed based on how far it has to move. If the carriage must move a large number of tracks, the voice coil system starts it moving very fast and gradually slows it down as it gets closer. The result is a very fast carriage movement.

Even in the stepper systems there is a large difference between drives. Table 1 shows some typical specifications for four important quantities: the disk motor startup time (the delay from the time the motor is started to the time when reading or writing can begin), the track-to-track movement time (for one track), the carriage settling time (the delay time after carriage motion stops to the time when it stops vibrating enough so it can be used) and the head load time (the delay from the time the head is commanded to touch the disk to the time it stops bouncing up and down so it can be used). (See Table 1.)

In what is called single density, one track can hold about 2500 bytes, or about 20,000 bits. This amount of data is not, however, written or read all at once. Instead, the track is divided into from eight to 18 smaller segments called sectors, with each sector typically holding either 128 or 256 bytes, plus a few additional bytes which may be used for synchronization or identification of sector.

To be interchangeable between drives, the disk format must be standardized and sectors placed in a specific place on each track. For that reason, the disk drive must have a way of sensing how far the disk has turned from some specific reference point.

Near the large center hole of the diskette are one or more small holes which allow the drive and controller to sense disk rotation. These holes are called index holes; the drive has a small light-emitting diode and phototransistor which shines a light through this hole and produces a pulse output each time the disk turns to a position where light can shine through the index hole.

Every type of diskette has one such hole which marks the beginning of what is called sector 0. In a way, this is the beginning of a track, except, of course, for the fact that the track is continuous and does not really have a physical beginning or end. Using this as a starting point, the disk controller can count sectors to identify all the other sectors on the track.

This is, however, where there is a difference between so-called soft-sectored disks and hard-sectored disks. In a soft-sectored disk, there is only one index hole, at the beginning of sector 0. Before it can be used, such a disk must usually first be formatted.

When formatting, the controller steps the head to each new track, waits for the sector-0 hole to pass through the index sensor light beam, and then writes a series of blank sectors on the track. Each sector is preceded by a header which consists of a string of synchronization characters followed by a sector number. Since the rotation speed of the disk is very closely controlled, the controller and its program have no trouble placing each sector in its approximately correct spot on the track.

Since the entire process is software-controlled, there does not have to be any specific number of sectors per track, although from eight to 18 are generally used. Typical formats might be ten sectors of 256 bytes each, or 18 sectors of 128 bytes each.

Once a soft-sectored disk is formatted, many disk systems no longer use the index hole, except perhaps to sense whether a disk is inserted in the drive or not. Since each sector is numbered, it is only necessary to step the head to the specified track and read off the sector numbers as they go past the head until the correct sector arrives.

Hard-sectoring is quite different. Now, in addition to the one index hole which identifies the beginning of a track, there are either ten or 16 additional holes, evenly spaced around the disk, which identify the beginning of each sector. (The spacing between the holes is uneven, so the controller can recognize which of the holes is the one marking the beginning of the track.)

Note that there is no difference in drives—the same drive may be used for either soft- or hard-sectored disks. Only the disk controller and the diskettes themselves change.

Soft-sectoring has the advantage of being more flexible, since the size of the sectors can be varied to meet the need. Hard-sectoring, on the other hand, can be more efficient since sector timing is a bit less haphazard. It is also not necessary to number each sector, since the controller can use the index holes to find each sector on the track.

Soft-sectoring in mini-floppies is generally handled by a disk controller such as the 1771 or 1791. Hard-sectoring, on the other hand, is generally handled either with discrete cir-

Time Spec.	Shugart SA-400	Wango/Siemens 82	MPI 51/52
motor startup	1 sec	1 sec	1 sec
track-to-track	40 ms	30 ms	5 ms
carriage settling	10 ms	20 ms	15 ms
head load settling	75 ms	60 ms	35 ms

Table 1.

cuitry, or by using some circuitry plus a serial synchronous IC such as the S2350 USART.

There is one more sensor in most disk drives—the one which tests whether a diskette is write-protected. Five-inch diskettes have a small notch cut into the side, which is detected either by a microswitch or via another photoelectric sensor. If this notch is absent, or if it is covered by tape, the disk is write-protected and the drive will not write on it.

Compatibility

The oldest five-inch floppy drives were made by Shugart Associates. Floppies were originally intended as a program transfer medium for minicomputers, not as main storage in microcomputers. As a result, no one ever anticipated that the demand would be as large as it has become.

Shugart soon found itself unable to deliver all the drives that customers wanted, and hence other companies went to work and designed their own drives. Although each company made its drives slightly differently (for patent as well as other reasons), the external appearance as well as interfacing and mounting details were generally identical with the Shugart drives. Customers could thus switch to a different drive without having to redesign their products.

There are some exceptions to this (as in Micropolis drives, which have traditionally been designed differently), but in general it is quite possible to unplug a Shugart SA-400 drive from a system and simply replace it by a Wangco/Siemens model 82, a Pertec FD-200 or an MPI model 51. The drives are the same size, the mounting screw holes are in the same place, and even the power and data connectors are the same.

There is also compatibility in the mechanical disk format. Not only do all these drives use the same disk, but they position their tracks in the same place on the disk, and maintain the same spacing between tracks. Thus, a disk written on one drive can—assuming the drives are properly adjusted—be read on another.

The tracks are normally spaced 1/48th of an inch apart; thus they are spaced at 48 tracks per inch (tpi). But the original Shugart disks had only 35 tracks, so that the distance between the outermost track and the innermost track is only about 3/4 of an inch. Since the oval slot through which the head reaches the disk is about 1-1/4 inches long, there is some extra room through which more tracks can be placed on the disk. Thus, most other disk drive manufacturers allow the head to go in for five more tracks, giving a total of 40 tracks.

(It appears, however, that BASF Flexy Disks, and perhaps others, have a shorter slot and cannot be used for 40 tracks.)

Though 40-track drives provide five more tracks than 35-track drives, the spacing between tracks and the positions of the first 35 tracks are identical. Thus, a 40-track drive can be used in a 35-track system and still be completely interchangeable.

Electrical Interface

Almost all five-inch floppy disk drives are advertised as being electrically Shugart-compatible. Since the same kind of connector is used in all, and since the logic signals almost always use the same pins in the connectors, there is true compatibility between them. (Except in one respect—an operating system designed to work with a drive which has fast head load time or fast carriage movement will not provide enough time for a slower drive.)

A five-inch drive connects to the system via two connectors and a single push-on-type ground lead.

A four-pin connector is used to bring power to the drive. A typical drive requires +5 V at about 0.5 amp, and +12 V at about 1 amp while running, and perhaps up to 1.8 amp when the motor is just starting.

The power connector needed is an AMP part number 1-480424-0 with four AMP 61473-1 or 60619-1 pins. It is most easily obtained as cat. no. 2480

Pin	Function
2,4,6	Spare
8	Sector sensor
10	Drive select 1
12	Drive select 2
14	Drive select 3
16	Motor on
18	In/out step select
20	Step pulse
22	Write data
24	Write enable
26	Track 0 sensor
28	Write protect sensor
30	Read data
32	Spare
34	Spare

Table 2.

from Hobby World (HW) Electronics for $1.99 each.

The data connection between the drive and its controller is normally done via a 34-wire flat cable with a 34-pin card-edge connector on the drive end of the cable. Suitable connectors are AMP part number 583717-5 or 3M Scotchflex 3463-001. These connectors crimp into the 34-conductor cable.

The other end of the cable usually attaches to its connector via another 34-pin card-edge connector, although sometimes a plug/socket connector is used, usually a 3M Scotchflex 3414-0000 or 3414-6000. (The matching connector for the controller board is then a 3M Scotchflex 3431-1002 right-angle connector or 3431-2002 straight connector.)

The 3M Electronic Products Division has sales offices in many U.S. cities, but the connectors are difficult to get because of minimum order requirements at their distributors; thus most computer users buy ready-made cables.

I have found two sources of these connectors, and the 34-wire cable, which are quite convenient:

Electrolabs (PO Box 6721, Stanford, CA 94305, 800-227-8266) has the wire at 68 cents per foot, card-edge connectors at $6.64, pin-type plugs at $6.58 and sockets at $4.47; the right angle pin-type plug for a controller board costs $2.77.

Another source is the International Minicomputer Accessories Corp. (Inmac), which has offices in most large U.S. cities, including Los Angeles, Denver, Dallas, Chicago, Detroit, Washington, DC and Boston. Their current prices are as follows: no. 1603 cable is $1.20 per foot, no. 1627 card-edge connector is $7.20, no. 1653 pin-type socket connector is $6.95 and the no. 1633 pin-type connector to a controller board is $4.70.

(These connectors are similar to those used on eight-inch drives, except that eight-inch drives use 50-conductor cable and connectors.)

A special—and expensive—crimping tool is recommended for crimping the cable connectors onto the flat ribbon cable. A very large bench vise could also be used (small, portable vises will not do the job), but I have had luck with a drill-press vise. In any case, very careful assembly is required because the connector cannot be removed from the cable once installed without damaging it.

Within the 34-conductor cable, the wires are numbered from 1 through 34, and all odd-numbered wires are used as ground. In other words, there is a ground wire separating each pair of adjacent data or control wires. On a card-edge or pin-type connector, however, all the odd-numbered pins appear on one side of the connector, while the even-numbered pins are on the other side. When the card-edge connector is plugged onto the edge of the board, all the grounds are on one side of the board, while the signal and control leads are on the other side.

Since card-edge connectors are seldom keyed, it is easy to plug the connector on the board backward, thereby shorting all the drive signal leads to the controller's ground and vice versa. This generally causes no damage (and is signalled by the fact that the drive motors run and don't stop), but should definitely be avoided.

Connector assignments are shown in Table 2.

(Note that some manufacturers refer to the first drive as drive 0, while others call it drive 1.)

All of these signals are normally

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high (above +2.4 V) and go low (near ground) when on. For example, to select drive 1, the controller would bring line 10 low, while keeping the other drive select lines high.

In multidrive systems, all drives are connected in parallel across the same 34-wire cable; the customary method is to crimp several card-edge connectors on the cable, separated by six to ten inches, with each connector plugged into a drive. All the signals are shared except for the drive selects. (This explains why all motors go on and off together in multidrive systems—there is only one motor control line.)

There is a difference here between five-inch and eight-inch drives. Five-inch drives use dc motors, and contain circuitry to turn the motor on and off in response to the motor control signal on pin 16. Eight-inch drives use ac motors which run directly off the 115-V (or 230-V) power line, and do not have any power control circuit. The motors will either stay on continuously or else require another circuit board for motor control.

The line assignments shown in Table 2 only provide for three drives, whereas in many systems four drives are desired. Line 6 or 32 is often used as a fourth drive select line. Drives which provide a door-lock mechanism to prevent the door from being opened while the drive is being used may use line 4 for that purpose.

When all drives are off, all drive select lines are held high by the controller. To select a particular drive, the controller pulls its drive select line low. That enables that drive to respond to the other control lines, while all remaining drives on the system remain disabled (or deselected).

Fig. 1 shows the wiring of a shunt, which is found inside each drive. The shunt has a small DIP-IC-like body which is plugged into an IC socket right near the card-edge input connector. The shunt is essentially a series of jumpers which connect opposite pins on the IC socket together unless broken; there is a thin area in the center of each jumper intended to be broken. (I've found that an easier—and reversible—method is to unplug the shunt from its socket, and simply bend up the pins to be disconnected before plugging it back in.)

The D1, D2 and D3 shunts select whether this drive will be the first, second or third drive in a system (TRS-80 owners—read on, because the TRS-80 does it slightly differently). For example, if the D1 shunt is left connected while D2 and D3 are broken, then this will be the first drive. Whenever drive select 1 goes low, the main drive select line inside the drive will therefore go low, and the drive will be selected. If D2 and D3 are broken, then nothing will happen here when the other drives are selected.

The HS and HM jumpers work together; one of them must always be installed while the other must be broken. These shunts control the head load solenoid. This is the solenoid which brings the disk up against the read/write head when reading or writing is about to be done. If the HS shunt is in place, then the head will load only when the drive is selected; if the HM shunt is in place the head will load as soon as the motor goes on. Either jumper could be used in a single-drive system. The HS shunt is usually used in multidrive systems because it results in less disk wear, and also in less likelihood of an accidental disk erasure in case of a hardware problem.

Systems using double head drives, however, often use the HM jumper even in multidrive systems. Although this increases the disk wear since the head is in continuous contact with the disk as long as the motor is turning, it reduces the severe disk wear which occurs when the two disk heads suddenly come together and clamp the disk between them. With the HM option, the heads only load as the motor goes on, not each time the drive is selected.

The MX jumper leaves the drive always selected when in place. This would normally be used only in single-drive systems.

In most multidrive systems the drives are connected in parallel across the 34-pin cable, and each drive gets all three drive-select signals; the selection of drives is then done by breaking two out of the three jumpers in the shunt. This means, of course, that you have to open the drive cabinet and manipulate the shunt.

Right next to the shunt, in an adjacent IC socket, is a resistor network that contains pull-up resistors which act as loads on the signal lines coming from the controller. New drives always come with this resistor package installed, but in multidrive systems only one resistor pack should be used, in the drive which is connected farthest from the controller. Again, this means that you must open the drive cabinet and remove all but one of these packs when installing a system.

In the case of the TRS-80, Radio Shack apparently did not want customers poking around the inside of the disk cabinets, and so they made three changes. First, they added a short extender board to the drive to bring the 34-pin card-edge connector outside of the cabinet (normally it is inside). Second, they gave the first disk drive a different part number from add-on drives, and they always supply the first drive with the resistor pack in place, while the add-ons have it already removed. This is the only difference between the two types of drive, but it does eliminate the need to open the box at all.

Finally, they left all three drive-select jumpers in place on each drive (with D1, D2, and D3 all connected), and instead do the drive selection in the cable by physically yanking out the appropriate pins from the card-edge connector. For example, the connector for the first drive has pin 10 but no pin 12, 14 or 32. Thus, the drive-select 2 and 3 signals do not even get to the drive, and so the fact that all three drive-select jumpers in the shunt are still there makes no difference.

Since the TRS-80 can support up to four drives, pin 32 is generally used as the fourth drive select. Some drives have pin 32 wired for that use, while in others pin 32 is a spare, or is even used for another purpose. For

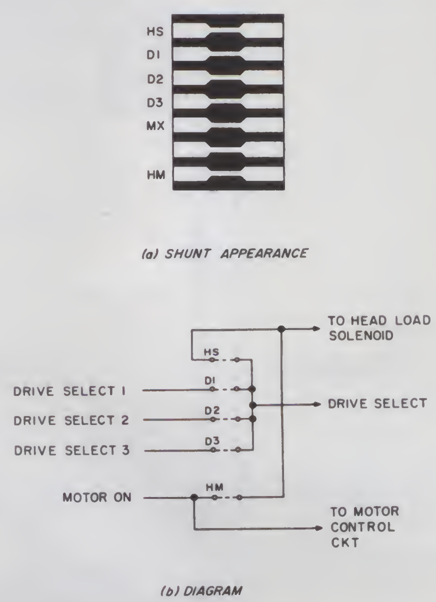

Fig. 1. The shunt.

➚337 for facing page. ⟶

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example, MPI model 51 drives use pin 32 to activate a side-select circuit (which is on the drive's printed circuit board, but not used). Thus, MPI 51 drives supplied for use with the TRS-80 usually have the trace to pin 32 cut, and a small wire jumper added to connect pin 32 to pin 14 or some other point in the drive-select circuit.

This is something which must be kept in mind if you switch either drives or cable between the TRS-80 and other computers.

Recording Method

To compensate for slightly different rotating speeds of the diskette, the signal written on the disk contains both data and clock pulses. Although the actual signal written on the disk is somewhat different, the read or write signal as it travels between the disk drive and its controller looks like that in Fig. 2.

Clock pulses spaced eight microseconds (µs) apart are recorded continuously on the disk, with data pulses placed roughly halfway between clock pulses. When a 1 is being written, the controller inserts a data pulse between the clocks; for a 0 the controller omits the data pulse.

If the data is a long string of zeroes, then only the clock pulses will exist with a spacing of eight us. In a long string of ones, on the other hand, pulses appear every four us. This is the reason why this method is called FM encoding, since the frequency of the pulses (which is one divided by the spacing) is low for a zero, high for a one. (Except for the timing, this scheme is very similar to that used in a TRS-80 cassette recording. In a Level II TRS-80 system, the spacing between cassette clock pulses is 2000 us.)

Thus, disk data bits are spaced eight us apart for a total of 125K bits per second. A complete eight-bit byte, therefore, is written or read every 64 us.

Disk data is written serially, one bit at a time. Since a microprocessor is simply not fast enough to convert data to or from serial format at eight us per bit, the conversion is always handled by external circuitry such as a 1771 disk controller or a USART.

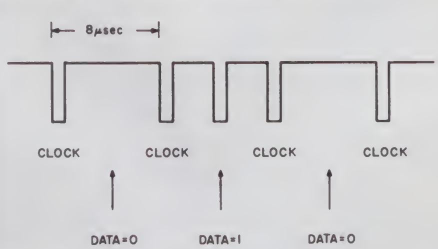

Fig. 2. FM data encoding.

This controller or USART, however, handles complete characters at a rate of one every 64 us. Most microprocessors are fast enough that they can move characters between the controller and main memory under program control as long as the program coding is carefully done and properly timed.

The data encoding described so far is the original recording and timing method, and is called normal or single density.

Double Density

In looking at Fig. 2 we see that every bit in single-density recording is accompanied by its own clock pulse. Hence the presence of the clock pulses effectively doubles the bit density of the disk—if we record 125,000 ones on the disk in one second, we are actually writing 250,000 pulses. Hence the disk drive as well as the diskette must be capable of handling pulses at a 250K bit per second rate.

If the clock pulses could be eliminated, then all of these 250K pulses could be used for data. This would double the data transfer rate, and would also double the storage capacity per disk.

This is the idea behind double density. Through a slightly revised encoding scheme called MFM (modified FM) or M2FM, the data and clock bits are combined, and therefore twice as much data can be stored. Since the effective data rate as far as the drive and diskette are concerned is unchanged, the same drive and disk can be used for double density as well as single—except for some very early disk drives (which are marginal performers), all floppy disk drives can be used with double density.

Note, though, that although double density doesn't affect the disk or drive, it does affect the computer. At double-density recording, the data bits are now only four us apart, and thus a complete byte is transmitted in 32 us instead of 64. At 64 us each character could be processed by the microprocessor; at 32 us there is much less time. Some processors, such as the 6809, are fast enough that with some very careful program coding, data can be moved to and from memory at that rate; but most com-

mon processors are not.

Thus, with some double-density disks, data must go to and from memory without going through the processor; that is, the controller must be able to bypass the processor and access memory itself. Thus, a double-density controller is more expensive and more complex than a single-density one.

One technique for doing this is via DMA, or direct memory access. When DMA is being used, the main processor starts the controller and then disconnects itself from the computer buses. The controller takes over and controls the address and data buses, as well as read/write and other control lines, and does its own transferring of data.

In most systems, a data byte can be transferred to or from memory in under one us. Since data bytes are only transferred once every 32 us, there is plenty of time to do a DMA transfer. In a simple system, the microprocessor might relinquish the buses long enough to transfer an entire sector's worth of data to or from the controller, but this obviously wastes time. In more complex systems the controller generates interrupts when it needs the bus, and the processor releases the bus just long enough to transfer one byte.

Either way, though, system timing becomes very complex. If there are sources of other interrupts or if the computer is being used for time-critical work, then the overall operation of the DMA circuitry must be watched very carefully.

Thus, some of the most expensive double-density controllers use a different technique. Instead of using DMA access to the main memory, these controllers have their own memory on the controller board, just big enough to store data from one sector. When reading or writing on the disk, the controller transfers data between its own memory and the disk at high speed. But data transfer between the main computer memory and the controller's memory can be done by the processor itself, under program control, when convenient. Though this scheme appears to be slower because it involves double data transfer, in practice it avoids other difficulties, and so is just as good as direct DMA but much simpler.

(This may be a good place to compare standard eight-inch floppy recording with the five-inch floppy. In the eight-inch floppy, the diskette rotates faster; the data bits also appear more often because the track diameter is larger, and thus there are more bits per track. As a result, the timing in single-density recording is half of that shown in Fig. 2—the clock bits are 4 us apart instead of eight. Thus, single-density must handle a byte every 32 us, while double-density recording handles a byte every 16 us. Thus eight-inch floppy controllers almost always use DMA or internal memory buffering on micro systems. This explains why five-inch controllers are so much cheaper. For example, a five-inch controller for a 6800 system can be purchased for under $100, whereas an eight-inch controller costs several times as much.)

So we see that double-density recording doubles the number of bits per disk as well as doubles the data transfer rate.

Double-Sided Operation

Floppy diskettes are coated with oxide on both sides even though they are intended for single-sided operation. This is probably done for mechanical reasons—so the diskette doesn't warp—but it does mean that the back side of the floppy can also be used.

When the read/write head in a drive is touching the diskette, a pressure pad on the opposite side presses the diskette against the head. To allow the pressure pad access to the diskette, the diskette jacket has a slot on both sides. This again means that the disk can be used on both sides. (Note, however, that diskette manufacturers do not test the back side of diskettes, and so the back side may sometimes produce errors. Special double-sided diskettes are available at extra cost and are tested on both sides.)

There is still a problem, however. The index sensor hole is not located in a symmetrical location. That is, when the diskette is turned over in the drive, the sensor hole is in a different place. Thus, in a basic drive, it cannot be read.

Some disk drive manufacturers have solved that problem by installing two parallel index sensors, one for use when the disk is inserted correctly and the other when the disk is inserted backward. With these drives, sometimes called flippy drives, it is easy to write on either side of a disk. (A second write-protect sensor is also required, since the write-protect

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notch is also in a different place now.) But even if dual sensors are not included, it is fairly simple to punch an extra set of holes in the diskette jacket—carefully!—to allow the single index sensor to check the index holes. Several suppliers are selling flippy kits for doing this; I have been doing it for years with a hand paper punch from a local stationery store.

Diskette manufacturers warn against the practice, however. As a diskette is used, the fiber layer inside collects dirt and dust and holds onto it. If the diskette is turned around, it now turns in the opposite direction, and hence much of this dirt and dust is released. They warn that this could result in increased disk and head wear as well as data errors.

The entire problem is alleviated with the new drives that provide two read/write heads, one on each side of the disk. Now either side of the disk can be written without turning the disk over. Not only does this double the storage per disk, but all the data on the disk is immediately usable. In other words, rather than appearing as two different disks, the disk can now be formatted as a single, large disk of double the capacity.

The idea of double-sided drives is fairly old, but until recently the drive manufacturers had trouble with the mechanical design. When the disk was clamped between two heads, it was often damaged by excessive pressure. In early designs, both heads were moved to and from the disk by the head load solenoid; most current designs leave one head in place and just move the other.

As far as the electrical interface is concerned, all of the leads on the 34-pin data connector remain the same except for one. Pin 32, which was formerly a spare, is now used to select the side. When this pin is high, the drive uses the normal side of the disk; if pin 32 is low, it uses the reverse side. With this convention, if a double-sided drive is plugged into a single-sided controller, pin 32 will be unconnected and therefore allowed to go high. The drive will then use the normal side as if it was single-sided.

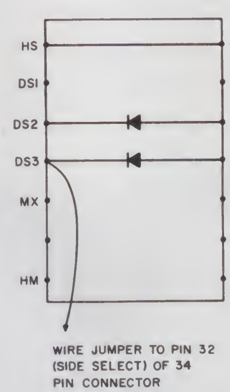

Fig. 3. Hardware side-select circuit. Diodes must be germanium junction diodes, not silicon.

It's important, though, to watch out for drives which are wired to use pin 32 for a fourth drive select. If these are mixed with double head drives in one system, some modifications will be needed.

Double-Track Drives

In normal five-inch drives, track spacing is held at 48 tracks per inch, and the total number of tracks is either 35 or 40. (Compare this with 77 tracks on an eight-inch drive.)

Several manufacturers, however, make drives which use narrower tracks and place them closer together. For example, the MPI model 91 and 92 drives use spacing of 96 tracks per inch, and so have room for 80 tracks instead of 40. (The model 92 is double-sided, and so has a total of 160 tracks, 80 on each side.)

In these drives, track 0 is in the same place as track 0 on a normal drive; track 2 is located the same as track 1 in a normal drive, and so on. Hence the even-numbered tracks lie on top of normal, or single-track, track positions; the odd tracks are sandwiched between. Thus, a double-track drive can read a normal diskette assuming that the software is written to do double-track stepping. (But it cannot write in normal track spacing because its tracks are narrower and it does not fully erase previous data over the entire wide track width on previously used disks.)

Double-track drives are substantially more expensive than single-track drives because of much closer mechanical tolerances required. Since the tracks are narrower, it becomes much more important to maintain disk-to-drive alignment. This means that the disk must be centered on the spindle more accurately, and much closer attention must be paid to temperature compensation and alignment. Some users also have some reservations about long-term stability.

The MPI Model 92 Drive

I recently obtained an MPI Model 92 drive. This drive is capable of double-density, double-sided operation,

and double-track spacing. Thus, it can hold eight times as much data on line as a standard single-density disk. At 160 tracks, with 20 256-byte sectors per track, this translates to 819,200 bytes of data per disk.

In actual use, though, total disk capacity is somewhat less than 819K for two reasons. First, soft-sectored disk systems require that each sector be preceded by some sync bytes and sector identification; this information takes up room and so the number of sectors per track is usually slightly less than 20; 18 is more common. Second, double-density systems generally use record track 0 in single-density mode. As a result, track 0 of all disks can be read on all systems, regardless of whether they are single or double density. Since track 0 contains information regarding the format of the rest of the disk, the disk operating system can then set itself to read the rest of the disk. Thus, though the theoretical capacity of such a disk is 819K bytes, in most cases the actual storage is somewhat under 800K.

The ultimate aim is to use it with a double-density controller; initially, though, I decided to test it at single density with two existing controllers on my 6800 system.

The first job was to modify the existing operating system to allow the use of 80 tracks per side. This is a very system-specific job, and I won't describe that here.

The next job was to make use of the second side. One way is to add a side-select circuit to the controller, and modify the disk operating system to keep this output high on the first 80 tracks and low on the second 80 tracks. A much better way would be to keep alternate tracks on opposite sides of the disk, since this would minimize head carriage movement while reading a file.

Both of these tasks require quite a bit of work, as well as a good knowledge of the (usually undocumented) disk operating system. I therefore chose a slightly different approach.

Instead of the plug-in shunt inside the drive, I substituted a plug-in DIP header. This is an assembly which plugs into an IC socket and is usually used to allow simple connection of discrete components like resistors to a digital logic circuit.

On this header I put the circuit shown in Fig. 3. The HS jumper is a wire, while the DS2 and DS3 jumpers are replaced by two germanium diodes. (Note: these diodes must be germanium junction diodes, not silicon. I used the base-emitter junctions of two old germanium transistors.) Finally, a short jumper from the DS3 diode's cathode was soldered to a tab connected to pin 32, the side select lead, of the 34-pin connector.

Using this circuit, the drive is selected as both drive 2 and drive 3, via the diodes. When either drive-select signal goes low, the diode pulls the drive's own select line low. (Germanium diodes must be used because they have the low-voltage drop needed to pull the output low enough. Silicon diodes don't work in this application.)

Thus, this one drive looks to the system as both drive 2 and drive 3. But when selected as drive 2, the side-select signal is high and so it uses the front side of the disk. When selected as drive 3, the side-select signal is low, and so it uses the back side of the disk.

Both sides of the disk are now us-

able and on-line at the same time, except that they are seen by the system as separate drives. Though this does give the full capacity of the disk, this arrangement has one disadvantage—if both sides were seen as just part of one disk, a very large file (larger than one side) would automatically be split so it lies partially on each side. However, this scheme does not allow that.

Does It Work?

This connection was tied with two different controllers and operating systems, but on the same computer. In one case it worked; in the other, it did not.

To avoid wasteful head movement, most operating systems keep track of the last position of the head carriage on each drive. For example, if the system writes data on track 13 and then goes elsewhere to perform another operation, when it returns to the drive it assumes that the head is still on track 13. This is a reasonable assumption to make.

But when a double-sided drive is wired as two separate drives, both sides must be on the same track. Suppose that the system moves drive 2 to track 13 and then does a read from track 30 of drive 3. Not knowing that this read has also moved the head on drive 2 to track 30, it now returns to drive 2 and expects its head to still be on track 13. But it's not, so we're in trouble.

One of my disk systems is soft-sectored and uses a 1771 controller. Since every sector on a soft-sectored disk is numbered, not just with the sector number, but also track number, then the 1771 controller immediately realizes that it's on the wrong track. It tries to re-read the sector a few times, but after two seconds or so does a seek back to track 0 and then back to the desired track. Thus there is a slight delay, but eventually it gets to the right track and reads or writes in the correct sector. The delay slows down operation, but is only present when alternate sides of the same disk are both used; if only one side is used continuously, then this problem does not appear.

My other disk system is hard-sectored. In this system, sectors need not be numbered (since the index holes are used to find the correct sector). Thus, when the operating system switches from one side to other it has no way of knowing that the head has been moved from its earlier position. And so it reads or writes in the wrong place, a serious mistake.

There are, of course, several ways of getting around the problem (by, for example, forcing the drive to go to track 0 when changing sides, or by patching the disk operating system so that the same location is used to keep track of the head position of both drive 2 and drive 3). In the long run, however, this is not the real answer. The best method would be to do both the hardware and software conversion so that the double-sided drive appears as one big disk rather than two smaller ones. (That is ultimately going to be done when I get a new Gimix double-density controller for my 6809 system.)

In any case, though, having 800 kilobytes on a single five-inch disk is quite an accomplishment. Though not quite as good as the 1.2 million bytes possible on an eight-inch double-sided, double-density diskette, it is much more compact and much less expensive.■

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This popular printer sets a high standard for dot matrix print quality.

The Epson MX-80: A Tough Act to Follow

By Frank J. Derfler

A home computer has many uses, but a lot of them are not really practical. For instance, I don't think anyone can honestly claim it is more convenient to keep recipes in a microcomputer than in a file box. But one of the most practical things you *can* do with a microcomputer is word processing. Most of us can see the value of being able to edit and cut and paste letters and other documents on a video screen before printing. The only drawback is the cost of a good letter-quality printer.

Three Approaches

There are essentially three ways to attack the printer problem. A high-quality high-speed printer will cost a minimum of $2000, and could run over $4000—that cost might be prohibitive. You might also require some unique software to fully exploit the power of an expensive printer. The quality, though, will be something to be proud of.

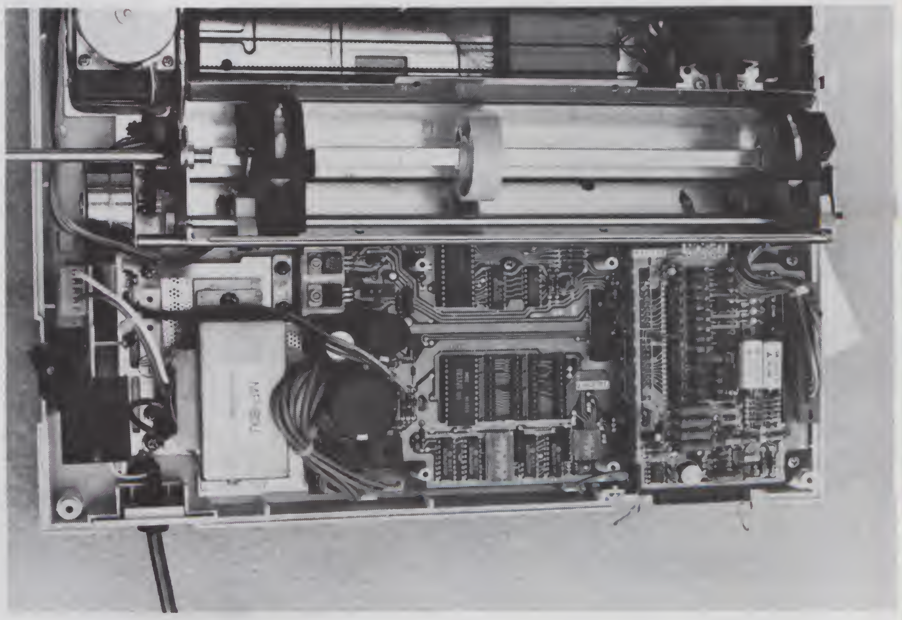
Surplus Printing Terminals

A middle-of-the-road approach involves using surplus printing terminals. The surplus terminals probably started life as input devices at car rental, airline or other remote locations serving large time-shared computer systems. These large systems usually did not use ASCII as a data alphabet, and they may not have used RS-232C as a signalling scheme. Many available systems have been converted to RS-232C ASCII communications, but the quality of the conversion varies. These surplus printing terminals are usually based on an IBM Model 72 Selectric typewriter, so the print quality can be excellent and you can change typeballs.

On the positive side, surplus printing terminals offer moderate cost ($600–$1200) and high quality. On the negative side, the quality of conversions and mechanical refurbishing is inconsistent. The speed is limited to about 110 baud. The printing mechanism is a mechanical nightmare for the uninitiated, although most local typewriter repair shops will recognize and repair the IBM mechanism once you persuade them to take a look at your unique beast. The cost of maintenance for the printing mechanism may be $100 a year or more.

Dot Matrix

Until recently, the last choice of anyone doing word processing was a dot matrix printer. The only things dot matrix systems had going for them were price and convenience.



The Epson printers contain a microprocessor which controls all functions. The empty sockets in the center of the picture hold additional ROMs for the GRAFTRAX II graphics option. GRAFTRAX II provides a great deal of capability in addition to the TRS-80 graphics set. It gives the MX-80 a high density graphics mode and italics in all 12 print modes. The GRAFTRAX II option costs $95 as a dealer installed retrofit and $50 if it is installed at the factory. The optional RS-232C serial board and an IEEE-488 standard interface board are also available.

Frank J. Derfler, Jr. (PO Box 691, Herndon, VA 22070) is the author of the monthly Dial-up Directory column in Microcomputing.

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The appearance of the dot matrix characters was definitely a negative factor. It took a large lump of rationalization and some self-deception to convince yourself that people enjoyed reading letters prepared on a standard dot matrix printer—they didn't, and they still don't.

But several new dot matrix machines that provide good to superb print quality have recently hit the market. As usual, there are some trade-offs in cost vs quality. The best dot matrix machines cost as much as the daisywheel and thimble machines, but provide more flexibility in operation. However, the most popular machine has a low price, and a print quality suitable for personal letters and documents for other computer users. This kind of printer is exemplified by the Epson MX-80.

10,000 a Month

This trade-off is certainly popular. Chris Rutkowski, the marketing manager of Epson America, Inc., claims sales of 10,000 MX-80s a month. This figure seems to be limited only by the capacity of the Japanese manufacturer to make and ship the machines. User groups for this printer have spontaneously sprouted around the country—unique for a peripheral device! Let's take a look at this hot-selling printer and see what makes it so popular.

The Epson MX-80 has two major attributes: good print quality and low price. The other features (which the MX-80 shares with some other dot matrix machines) include small size, low weight, low noise, great operational flexibility and mechanical simplicity.

Too good to be true? It all depends on exactly what print quality you are willing to settle for.

Print Quality

Fig. 1 shows the quality and types of print available from the Epson MX-80. The machine uses a 9×9 dot matrix printhead for characters, and produces graphics in a 6×12 dot format. The lowercase characters have true descenders. The lowercase s probably shows the dots more clearly than any other character. Other lowercase rounded characters such as the a and e also show the dots, but not as clearly. The s is made up of 14 dots. In the double-strike mode, the paper is rolled up 1/216 inch and the character is printed again. The s is then made up of 28 dots slightly dis-

Various print styles are available on the MX-80.
If different print styles are desired on one line or
on one page, it is necessary to use BASIC PRINT
statements to send the correct text and commands
to the printer.

This is an example of double struck printing. It is a printing method which actually scrolls the paper vertically and then prints again to fill in the spaces between the dots. Some people like this mode, but others don't.

Double striking can be combined with another mode called Emphasized Printing.

A compressed mode is also available which gives 132 columns of print per line. This is very handy for some statistical programs which assume you have an 80 column printer. With the MX-80, You DO!

The EPSON MX-80 also has a graphics capability:

Fig. 1. Sample printout showing MX-80 print styles.

placed in the vertical axis. Some people find this print quality pleasing because it smooths out the dots; others claim it is fuzzier, and prefer the single-strike mode.

The different print styles are easy to use from BASIC, but they are much more difficult to mix on a single page when using a word-processing program. The most practical method of mixing print styles on one page is to write your document as BASIC "PRINT" statements. If you are using a word-processing program and want an entire page or document done in only one typeface, you must load BASIC, send an ASCII number out the I/O port to instruct the printer and then load your word-processing program. This could get a little cumbersome with tape-based systems. It isn't bad with disk systems, as long as you remember to save the document you have been working on before you go to BASIC.

Graphics

The printer contains a graphics set essentially the same as the one used in the TRS-80 Model I. When it does graphics it doesn't simply copy the screen—it reproduces the figures in its ROM, based on received ASCII codes. If you have a computer with no graphics set, the printer will still respond to the codes. If you have a more elaborate graphics capability, the printer will still only produce what is in its own ROM. If you have a TRS-80 Model I, what you see is what you get (see Fig. 2).

Connection

The Epson MX-80 is easy to interface with most computer systems. It plugs directly into the Centronics parallel port. However, the standard Radio Shack parallel printer cable will not allow separation of the carriage-return and line-feed signals. Epson says their special cable is needed to separate these signals if the printer is to do underlining and other special printing.

If you don't need a separate CR and LF, the standard cable will work fine. This is a little hard to understand since each of these signals is a separate ASCII code, but the cables work as advertised. The Epson MX-80 prints bidirectionally at a nominal speed of 80 characters per second. A machine connected through a parallel port has no problem in printing along with a 300 baud input.

An optional RS-232C serial board is available for the printer. This interface is not quite so simple because it uses RS-232 pins 11 and 20 as clear-to-send lines. The Epson cannot hold or buffer serial data while it does a carriage return, line feed or form feed. If the computer does not stop transmitting, characters will be lost. When it needs some breathing room, the printer sets pins 11 and 20 to a low condition.

This kind of interface requires more complex driver software than most RS-232C ports commonly provide. Epson would probably have served the user better if they had included enough bytes of memory on the serial card to hold a few characters during mechanical operations. An IEEE-488 standard interface is also available for use with Commodore microcomputers.

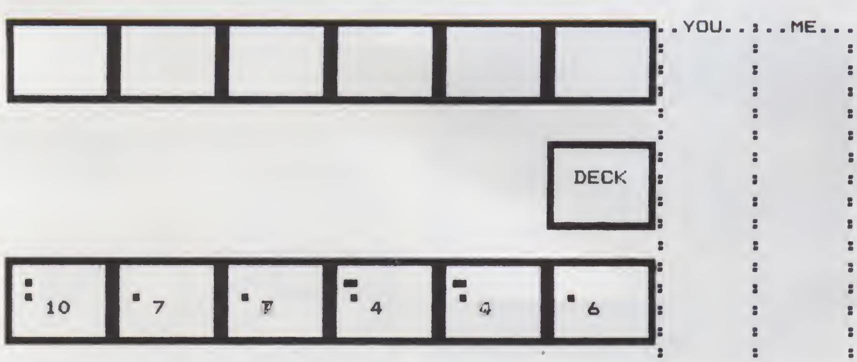
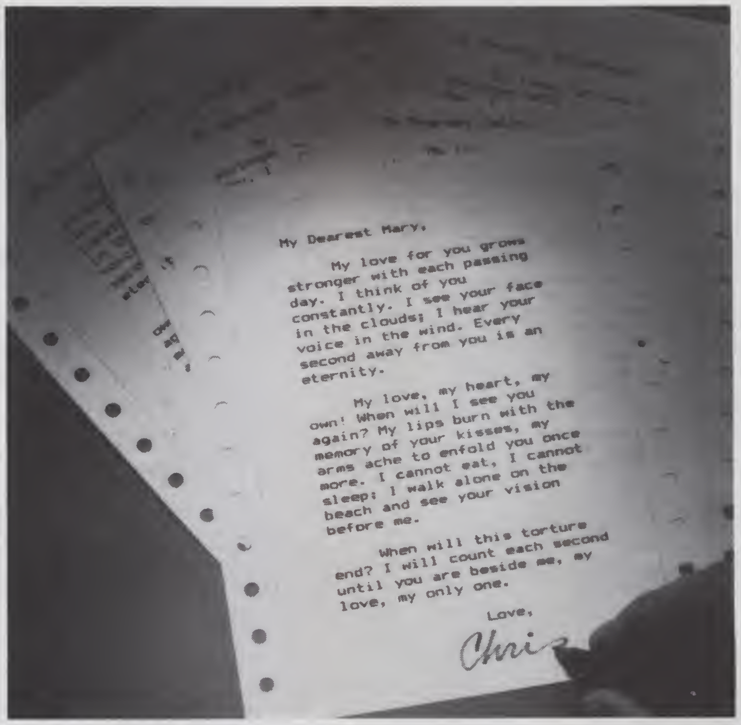


Fig. 2. Screen dump showing the opening hand of Instant Software's Cribbage program.

Construction

The Epson MX-80 has held up well under heavy use. The power supply

We're known for our fine print.



Epson.

The type you get out of most printers you wouldn't send to your maiden aunt, much less use for your *important* correspondence. And up to now, in order to get a dot matrix hardcopy you could really call correspondence quality, you had to spend on the high side of a thousand bucks.

Not any more.

The Epson MX-80 challenges any dot matrix printer anywhere to match our type at our price. Or even come close.

Our emphasized print mode gives you a tack-sharp, clean, easy-to-read face with true descenders—at a fraction of the price of daisy wheel printers. We give you a user-defined choice of twelve different weights and sizes of letters in 40, 80, 66 or 132 columns. We give you adjustable tractors so you can do anything from labels to memos to manuscripts. Fast and clean.

But if you think print quality is the only thing we have to sell, you're wrong. The MX-80 may be the most revolutionary printer to come out in the past ten years.

For starters, it features the world's first *disposable* print head—after it's printed between 50 and 100-million characters, just throw it away. A new one costs less than $30 and you can change it yourself with one hand. Plus, the MX-80 prints bidirectionally and 80 CPS with a logical seeking function to minimize print head travel time and maximize throughput. Finally—and this is the best part—you can buy an MX-80 right now for less than $650.

And that's what we call a lot of fine print for the money.

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transformer (no wall transformer!) runs cool. The printer has passed the FCC certification test for rf radiation as a class B (home computer) device, so it should not significantly interfere with local television or radio receivers.

The printhead is easy to replace and costs about $35. This is a fraction of the cost of printheads on competing dot matrix printers.

The tractor-feed mechanism is simple but effective. Perforated paper tears cleanly along the top cover, but it takes a little practice to manually roll the paper back down so the top of the next page is aligned with the printhead.

Documentation

The *MX-80 Printer User's Manual* is a witty book which provides over 100 pages of directions, hints and diagrams. David A. Lien is the author, and he has used a very readable style which encourages MX-80 users to get the most out of the system.

A separate service manual is also available—it is informative, but not as much fun to read. Most MX-80 owners would benefit from having the service manual around. It contains clear instructions and exploded-view mechanical diagrams. Several trips to the local dealer for simple lubrication or alignment can be avoided through the use of the service manual.

Psychology

OK—this printer is reliable, easy to use and reasonably priced, but can it be used for real word processing? That question will raise an argument in many circles.

Chris Rutkowski claims that people will soon expect dot matrix and tractor-fed paper with little perforation marks around the edges. They will think you are inefficient and extravagant if you use single-fed sheets and high-priced printers. His vision of the future may be colored by his desire to keep his sales up, but it certainly is true that the print quality of the MX-80 is good enough for many uses.

If tractor-feed doesn't suit your needs, a newer version (the MX-80 F/T) is now available with a pressure-feed capability (for $745). Don't confuse the MX-80 with its less capable brother, the MX-70. The 70's print face isn't nearly as pretty, and for some reason its operational reputation is not as good.

The MX-80 lists for $645, but you can find it advertised here in *Microcomputing* for under $500. At that price, you will have to judge if it is good enough to meet your word-processing needs. ■

Epson's Newest Printer

Epson has just added the 136-column MX-100 to its series of technologically-advanced dot matrix printers.

The MX-100's predecessor, the MX-80, is now the largest-selling 80-column dot matrix printer in the world.

The MX-100 uses dot matrices ranging from 9×9 to 18×18 to generate correspondence-quality printing in a total of 12 different character weights and sizes. The new printer also features Epson's Micro-Nine disposable printhead, and GRAFTRAX, a high resolution bit image graphics capability.

Because the printer accepts paper up to 15.5 inches wide, it is capable of printing up to 233 columns in the condensed print mode. It prints bidirectionally at 80 cps, with a logical seeking function to minimize printhead travel time and increase throughput. It comes standard with both a friction paper-feed platen and adjustable tractors on a removable tractor mechanism.

The MX-100 is currently available at a suggested retail price of $995. For more information, contact Epson America, Inc., 23844 Hawthorne Boulevard, Torrance, CA 90505.

Epson's new MX-100 is a 136-column wide printer in the normal 10 character per inch mode. In the compressed mode of 16.5 characters per inch it can print 233 characters on paper up to 15.5 inches wide. It can handle both pin feed and cut sheets.

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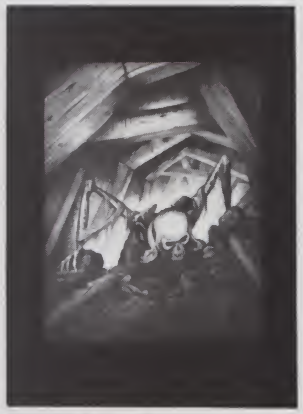

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The Stone of Sisyphus carries you to the "thinking man's" dungeon. A subterranean world of monsters, magic, traps and treasures demands brains rather than luck to survive (of course, you might take along your mace just in case...). A compacted data structure makes it possible to run this fantasy on a single disk drive, though 2 full diskettes worth of data are supplied. Expanded use of free-form input puts your ingenuity to an even greater test. The responsiveness of the programs to the individual qualities of the character make this adventure frustratingly enjoyable for hundreds of hours before its secrets can be unlocked.

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This successive approximation register helps you better understand analog-to-digital conversion.

How to Cope With an Analog World

By Theodore T. Tylaska

Analog to digital converters (ADC) are absolute necessities whenever a digital computer is used to sense analog signals in real-world applications.

There are several ways to convert an analog voltage into an equivalent digital number. The successive approximation technique is the most popular, because it is a good compromise between speed and required hardware. The key control element in the successive approximation ADC is a medium-scale integration device called the successive approximation register (SAR).

This design for a four-bit SAR constructed from small-scale integrated circuits will help you better understand the operation of this important register. Support components are added so that an operational successive approximation ADC can be constructed. LED indicators and single-step switches are included in the design so that the operation of the SAR can be observed for each clock pulse.

Successive Approximation: An Overview

For an overview of the principles of the successive approximation ADC, study the block diagram in Fig. 1. Notice the ADC requires a digital to analog converter (DAC) plus other parts. Thus, the cost of an ADC is usually two to three times the cost of an equally accurate DAC itself. Successive approximation analog-to-digital conversion is a more time-consuming process than digital-to-analog conversion. The explanation of the SAR will clearly show that conversion time is a function of the number of bits of precision in the converter.

The A/D conversion process begins upon receipt of a start conversion pulse. The successive approximation register sequentially turns on each weighted bit of the D/A converter to compare the voltage produced by that bit to the input voltage. The most significant bit (MSB), B3 of the D/A, is turned on first, and the output of the comparator is noted.

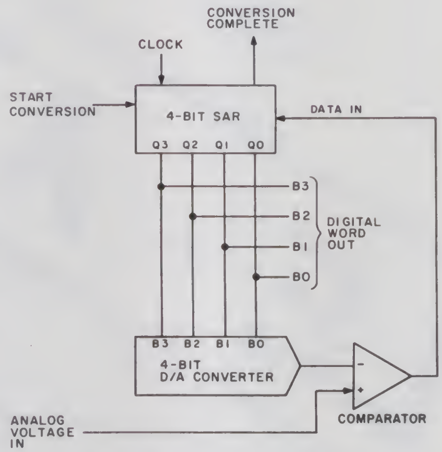


Fig. 1. Block diagram of four-bit successive approximation A/D converter.

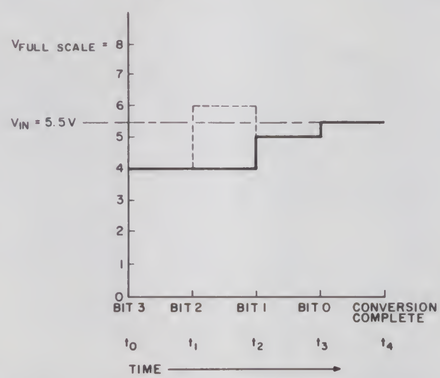


Fig. 2. Successively approximating an analog voltage.

If the D/A output voltage is less than the analog input voltage, the MSB is left on in the successive approximation register; otherwise, the MSB is turned off in the SAR. The next MSB, B2, is turned on, and the summation of the voltages produced by B3 and B2 from the DAC is compared with the analog input voltage.

If, for example, the output of the DAC exceeds the value of the input voltage, then bit Q_2 is turned off in the SAR. The process continues until the least significant bit, B0, of the DAC is set, and a comparison is made between the input analog voltage to the ADC and the DAC output voltage. If the ADC has n bits of precision, there must be n comparisons made.

This method is also called a binary approximation technique, because at each stage of the conversion a comparison is made of one-half the remaining difference to determine whether that bit is required in the approximating voltage sum. Thus, the first step in the successive approximation process must determine if the input exceeds $V_{fs}/2$, where V_{fs} *is the* full-scale input voltage of the ADC. The second step determines if $V_{fs}/2^2$ is needed, and the nth stage determines if the weight of $V_{fs}/2^n$ is needed to approximate the input voltage. In general, n + 1 clock pulses are needed to perform the approximation. The first clock resets the SAR, and each succeeding clock determines the need for each successive bit.

An example of approximating a given voltage with a four-bit SAR feeding a DAC is shown in Fig. 2. The voltage to be approximated is 5.5 V. Assume the ADC full-scale output voltage is 8 V. The first approxima-

Address correspondence to Theodore T. Tylaska, RFD 1, Box 230, Mystic, CT 06355.

tion sets bit 3, whose weight is 4 V. The second clock cycle attempts to set bit 2 with a weight of 2 V, but the resultant sum from the DAC is 6 V, which exceeds 5.5 V. Thus, bit 2 gets reset to a zero. At the third clock cycle, bit 1 is next turned on and the DAC adds 1 V to the sum which now totals to 4 + 1 = 5 V. Since this is less than 5.5 V, bit 1 remains set to 1. Bit 0 adds 1/2 V to the sum to exactly equal the 5.5 V so bit 0 remains set to 1. The resulting digital word is $(1011)_2$.

Now that the function to be performed by the successive approximation register has been examined, an implementation of the SAR can be surmised. If a four-bit SAR is being designed, the SAR must have some control method to selectively turn on or off each successive bit being tested. A four-bit shift register could fill the bill for control with a single "one" being shifted through the register. The presence of a "one" at a given stage of the shift register could signify that the corresponding bit in the SAR is being tested. The control circuit in Fig. 3 shows an arrangement for such a control shift register.

This register is implemented out of 74LS74 D-type flip-flops. The control register is started by an initialize pulse, which causes 1 to be directly set into the first stage flip-flop, IC1A, and 0 to be directly set in the other four stages of the register. The last flip-flop, IC3A in the register, is used to hold the conversion complete condition.

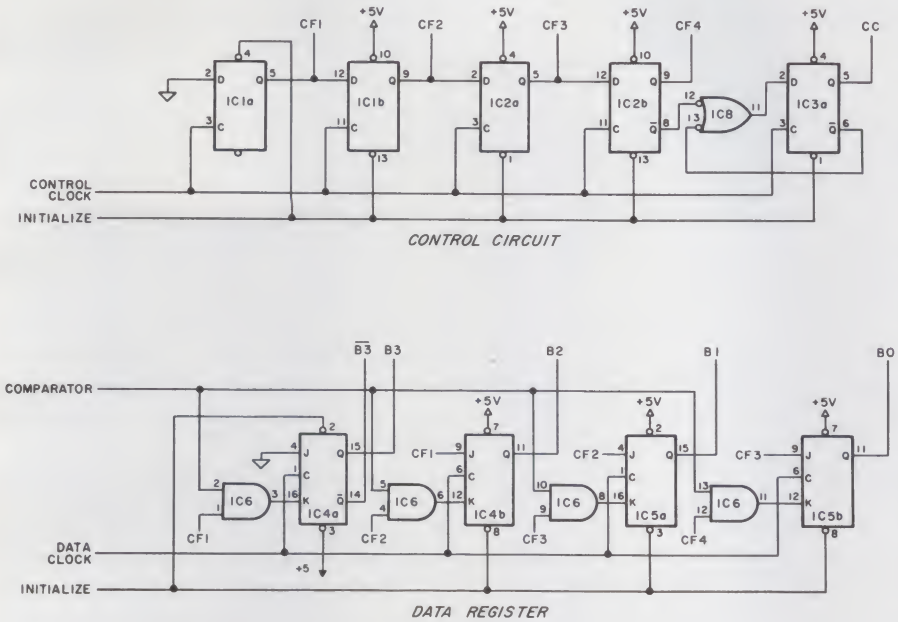


Fig. 3.

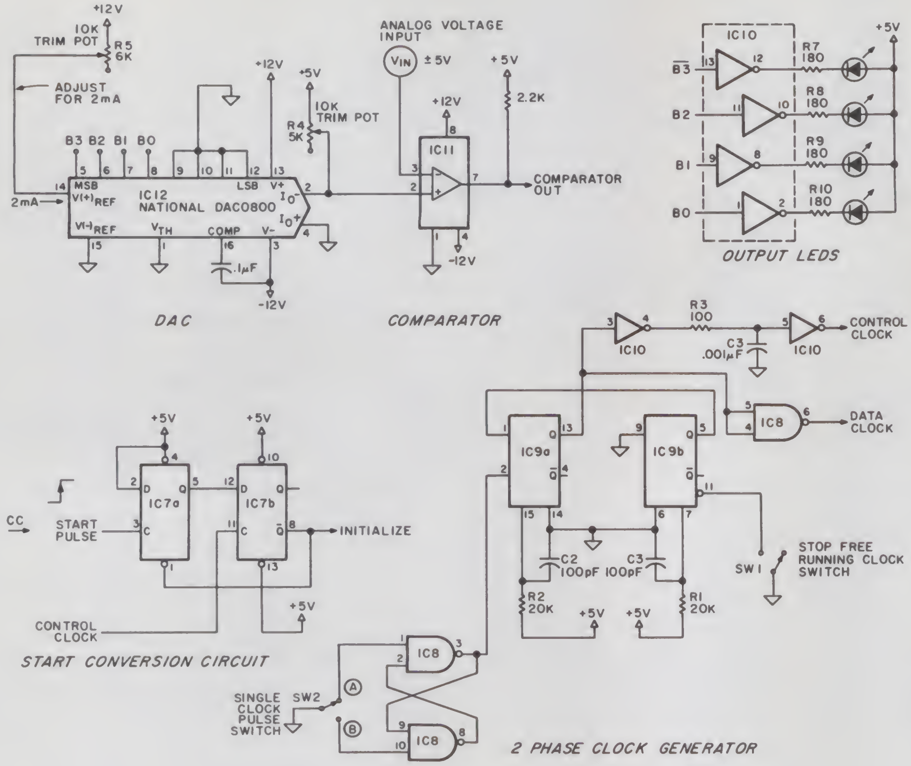


Fig. 4.

Conversion complete occurs when the "one" preset into the first flip-flop has shifted into the fifth flip-flop. The OR gate IC8 holds the conversion complete condition in IC3A in the presence of continuous control clocks. At this time the result of the conversion can be read out of the data register.

The data register is another set of four flip-flops which is used to hold the information as to whether or not each weighted bit of the DAC is needed to approximate the given input analog voltage. The data register is implemented by two 74LS76 J-K flip-flops as shown in Fig. 3. The initialize pulse sets bit 3 on, and turns off the remaining bits, B2, B1 and B0. Bit 3 is wired to the most significant bit of the DAC to generate the comparison voltage of $V_{fs}/2$.

The comparator output from IC11 feeds the AND gate IC6 to determine whether a clear signal should be applied to the K input of the flip-flop IC4A to reset it. If the comparator output shows that $V_{fs}/2$ is less than the unknown applied voltage V_{in}, then the comparator signal is low and flip-flop IC4A remains set with B3 high. During the next data clock pulse, bit 2 from flip-flop IC4B is turned on to supply $V_{fs}/4$ from the DAC output.

Again, a comparison is made between V_{in} and the DAC output caused by the weighted sum of bit 3 and bit 2. This process will continue until bit 0 is summed into the accumulated output voltage of the DAC. A set of LEDs is connected to the data register outputs as shown in Fig. 4.

Two Clock Phases

The SAR is controlled by two clock phases called the control clock and the data clock. The clock generator IC9 is a 74LS123 dual monostable. The two monostables are cross-coupled to produce a square wave of period 2.4 us with the specified timing components. Closing switch SW1 disables IC9B and prevents the generation of a continuous train of clock pulses. While SW1 is closed, moving SW2 from position A to B and then back to position A will generate a single control clock and a single data clock pulse. Thus, you can single-step the SAR and observe on the LEDs the setting and clearing of each of the data flip-flops, depending on the result of each voltage comparison.

The timing diagram in Fig. 5 shows

the rising edge of the control clock to be delayed from the falling edge of the data clock. This delay is implemented by resistor R3, capacitor C3 and IC10 to give a delay of 250 ns. Switch SW1 must be open and SW2 must be in the A position for the clock to free run. IC8 serves as a clock buffer.

The start circuit in Fig. 4 is implemented by two D-type flip-flops in package IC7. The start pulse is a rising edge, and it can be applied at any time. The timing diagram shows the start pulse setting flip-flop IC7A. At the next rising edge of the control clock, IC7B is set because its D input is 1. The initialize signal that sets the correct state in the control and data registers and also clears IC7A is generated. On the next control clock rising edge, IC7B goes to 0 and removes the initialize signal.

Control flip-flop CF1 remains high during control clock period 2. Since B3 is set, the DAC is making a trial comparison with its output at $V_{fs}/2$. At the falling edge 2 of the data clock, the decision is made to keep B3 or to clear it. At the same time B2 is set because CF1 is applied to the J input of IC4B while its K input is 0.

At rising edge 3 of the control clock, CF1 is cleared and CF2 is set. This conditions the K input of B2 to give a clear signal or not, depending upon the result of the comparison of the DAC output with the input voltage V_{in}. At falling edge 3 of the data clock, the decision is made to keep B2 set or clear it, and at the same time to set B1.

At rising edge 4 control flip-flop CF2 is cleared and CF3 is set to condition data flip-flop B1. This process continues until all the bits are tested, at which time the conversion complete (CC) signal on IC3A comes true.

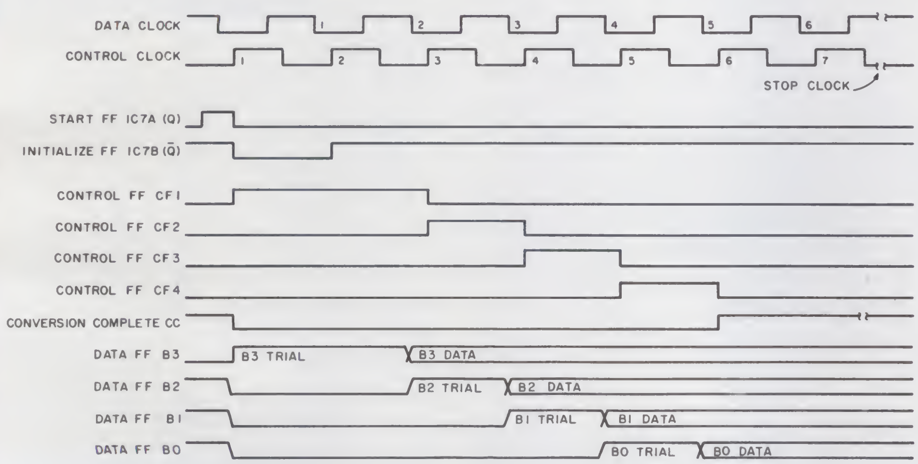
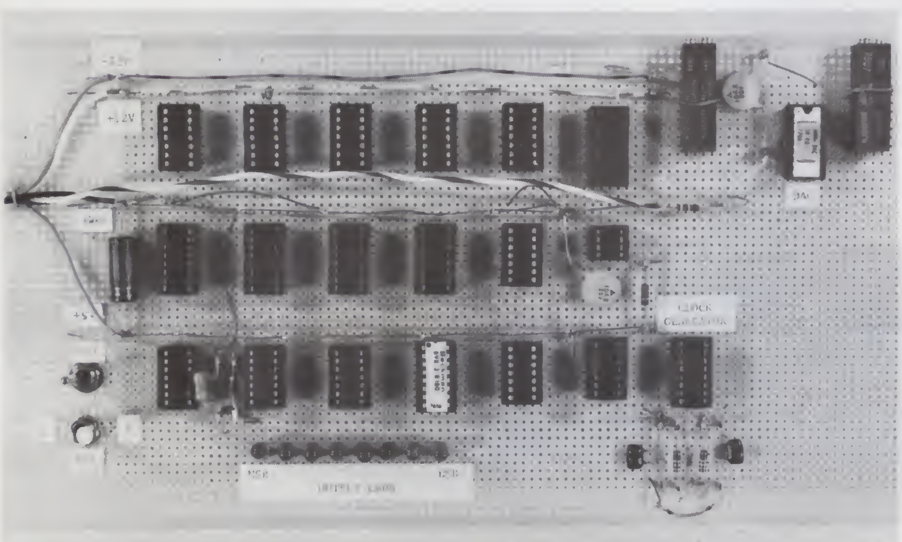


Fig. 5. Timing diagram for successive approximation register.



The successive approximation register. Note the position of the components on the prototype.

To have the converter operate continuously, simply wire the CC signal to the conversion start signal.

A complete ADC can be built by adding a DAC and a comparator to the successive approximation register. The DAC shown in Fig. 4 is an eight-bit National DAC 0800LCN, which is wired to use only four bits. Resistor R5 is chosen to be 6k, so that 2 mA of reference current flows into the $V_{ref}(+)$ pin. The selected reference current determines the maximum amount of current that can flow into the $I_0(-)$ pin. Thus, $I_0(-)$ of the DAC varies from 0 mA with a digital input code of $(1111)_2$ to 2 mA with a digital code of $(0000)_2$ placed on pins 5 through 8.

Resistor R4 is then chosen so that the voltage on pin 2, $I_0(-)$, varies from +5 V to −5 V. A 5k resistor will be needed as 2 mA × 5k equals the 10 V drop needed across R4. The code produced by the data register could be interpreted as straight binary for unipolar input voltages, or as offset binary for bipolar input voltages. The design in Fig. 4 will accept bipolar voltages of ±5 V. By connecting $\overline{B3}$ instead of B3 to the MSB LED light, the successive approximation register generates two's complement code.

Conclusion

It is easy to see that additional bits could be accommodated by adding more control and data flip-flops with the rest of the circuit remaining the same. Try building this circuit, which is very practical and can convert as fast as the DAC output can settle. You will end up with a good understanding of how a successive approximation register operates.■

Parts List

C1,C2	—100 pF mica
C3	—.001 capacitor
IC1,2,3,7	—74LS74
IC4,5	—74LS76
IC6	—74LS08
IC8	—74LS00
IC9	—74LS123
IC10	—74LS14
IC11	—LM 311
IC12	—National DAC 0800LCN
R1,R2	—20k ohm 1/4 W
R3	—100 ohm 1/4 W
R4,R5	—10k ohm trimpot
R6	—2.2k ohm 1/4 W
SW1	—SPST toggle switch
SW2	SPDT toggle switch

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This easy-to-build video system offers high-density graphics as well as programmable characters.

Videographic

By Joe Martinka

My wife was studying for a college degree in French, and had to write several papers every semester. I had spent a delightful two years with a simple Heathkit terminal hooked up to my home computer, and decided it was time to provide her with one of its most valuable services: text editing and formatting. But first I needed upper/lowercase video display capability, something the old Heathkit terminal did not have.

I was willing to consider the easy but costly option of buying a video display ready to go. But after scanning the microcomputing magazines, I soon realized that this option would be too expensive. Consider that I included as necessary specifications:

- Programmable special characters. An indispensable feature, since most of her text processing would be in French, and would require special accents and the like.
- Eighty characters per display row, 24 lines on screen, and a versatile 8 by 12 character matrix.
- Compatible with 4 MHz processors.
- Memory-mapped video for ease of screen update and programming.
- Programmable cursor control and reverse video capability.
- Graphics capability. To make the board useful for my own games and display needs, I had to be careful that limited hardware capabilities would not confine my imagination. I wanted good resolution—256 by 256 would do nicely for games, graphs and chart programs.

Photo 1. Overall view of the author's system. Involves a home-brew system boasting a 4 MHz Z-80A processor, 48K RAM, North Star disk system and the Videographic video interface. The large keyboard to the left houses a one-of-a kind Selectric interface for hard-copy output. The Selectric typewriter itself is not shown.

A reasonably priced commercial video board would satisfy only some of the above specifications. Some were tailored only to a certain processor, some were too slow and some had no graphics at all. I then decided to do what any true-blooded computer lover would do—build one myself. Thus, Videographic was born.

The advantages I gained by designing it were satisfying. I was able to accommodate my S-100 bus running a 4 MHz Z-80 microprocessor. See Photo 1. I could shift the entire mode of the video board from a character-oriented display to a full-graphics mode with a single input-output command. I used a new and exciting programmable video-display-controller integrated circuit, affording excellent versatility: as my needs change, I can change the mode of the display simply by reprogramming the video dis-

Address correspondence to Joe Martinka, c/o Microcomputing.

play chip. Lastly, I made use of a spare Godbout Econoram 8K static memory board that reduced my costs even further.

Videographic's abilities are summarized in Table 1. It is easy to build this board, or one like it, emphasizing your own personal needs. The rest of this article will show you how.

Theory of Operation

As the block diagram in Fig. 1 indicates, Videographic is a relatively simple concept built around the Motorola MC6845 video chip. Originally designed for the 6800 and 6502 microprocessors, the MC6845 can be made to work with the faster Z-80A. The static RAM memory is shared between the 6845 and the host processor. The 6845 uses the memory continually as the source of information for TV screen updates, while the host processor can access the same memory as easily as it can regular memory. Hence the label: memory-mapped video.

While I use the Godbout board, there is plenty of room on the main board for your own memory chips (Photos 2 and 3). By using the popular 2114 static RAM chip, you can implement 8K memory using only one-eighth of the chips you see on the Godbout board. I used the extra board because I already owned it. You could use existing memory, too. The changes you would have to make to the circuit are negligible. Choose the way that is easiest for you.

The video display chip, the Motorola MC6845, performs all the necessary video timing and refresh functions needed to produce a truly inexpensive high-density display. It can generate timing for almost any alphanumeric screen density, from 40 × 12 to 80 × 24. It is powered by a single ± 5 V supply, offers hardware scrolling by character, line or page, as well as various cursor modes and light pen capability. The 6845 can address up to 16K of memory. (In Videographic, I make use of half that amount.)

The reader should obtain the technical notes on the 6845 from a local Motorola office before using the chip in his own application. A 20-page booklet is available describing the operation and programming considerations of the 6845. The versatility built into the video display processor is explained in detail, and is available from the address listed in Reference 1.

The 12.440 MHz clock provides the basic timing and "dot clock" for the entire display. The 12.440 MHz signal is used to clock the shift register that feeds dots to the video combiner circuit while in the character mode. (One-half of that rate clocks the dots out in the graphics mode.) This dot clock frequency is divided by eight to provide the character clock, and is the signal that controls the transfer of characters between portions of Videographic.

A programmable 5-V 2K × 8 EPROM, the 2716, is used as the character generator. Using this chip, you can literally create your own character set. I created mine using an 8 by 12 grid on which I had placed pennies to form the style I liked, which included descenders and unusual French alphabetics. (By squinting at the grid, you can imagine what the letter would look like on the screen.) Fig. 2 shows the dollar sign character being formed. The contents of my EPROM are shown in Listing 1. The characters at the left of the listing are only typewriter references and do not show the actual shape, as the typical character display in Photo 4 does.

You can avoid the hassle of EPROM programming your own custom characters if you can be satisfied with a factory-programmed character set. Unless you can obtain the use of a programmer, it would be significantly more economical to use popular chips such as the 6072 or the MCM66750, which are no more than one-chip ROMs. A 2716 EPROM or a

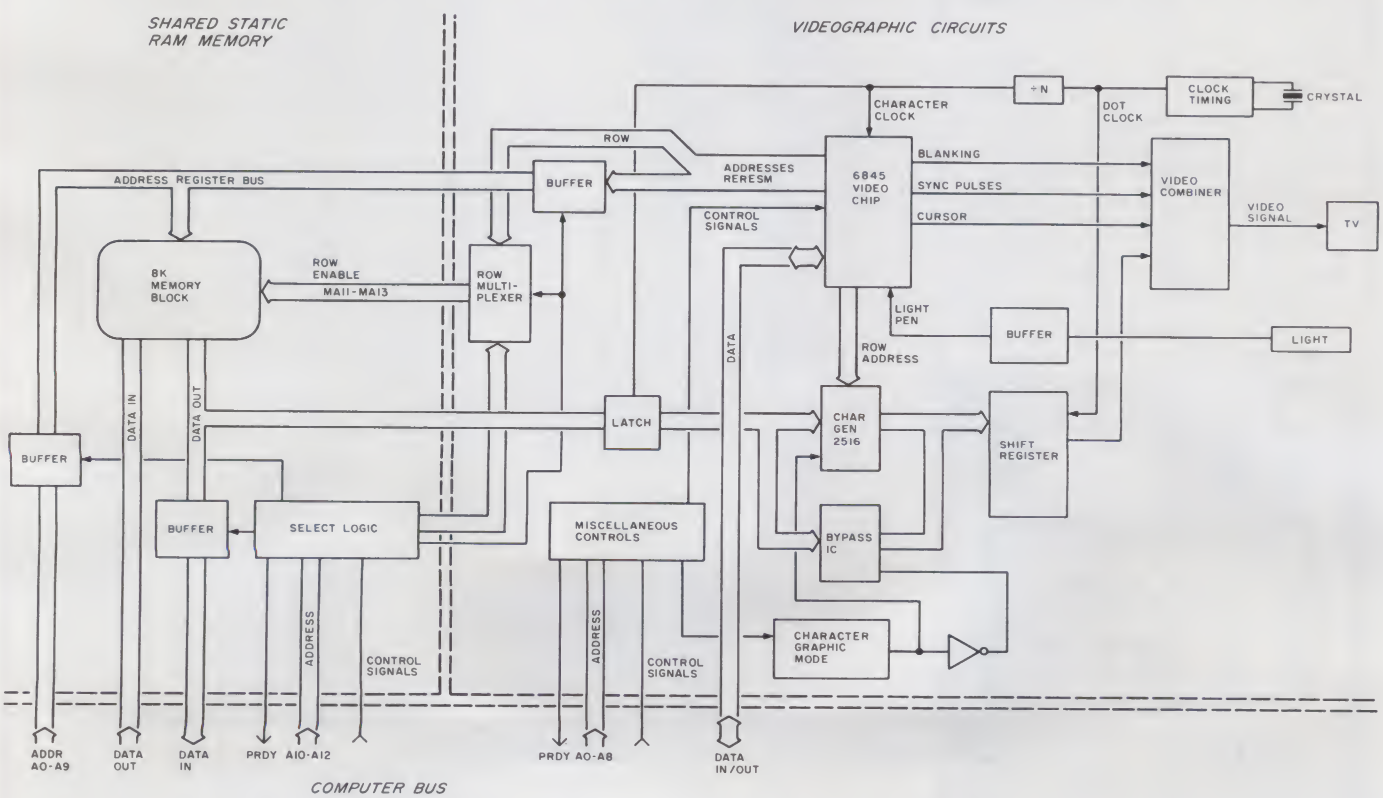

Fig. 1. Block diagram of the Videographic circuit based around the Motorola MC6845 video display controlier.

factory-programmed ROM will work equally well in the character generator spot with only minor socket-wiring changes.

At a given value of row count, the 6845 will put out the addresses of a series of 80 characters of refresh memory. Then it increments the row count and repeats the series of 80 addresses to the programmed total of 12 times, to paint all rows of the dots on the screen for the whole character line. Then the row count resets to zero and the process is repeated for the next line. You program the 6845 to output the vertical and horizontal sync pulses at any specified moment in the timing so that the video chip will adapt to nearly any monitor or modified TV. This feature of the 6845 lets you center the display by merely changing one or two software bytes.

Videographic can reverse any character to black-on-white with bit 7—the most significant bit—set to 1. This feature can be used to highlight blocks of text, or create a screen that looks more like words on paper.

The 6845 accesses the shared memory through a multiplexer, which can be thought of as a 13-pole, two-position switch. The position of this switch is such that the memory is normally driven by this 6845 update

Listing 1. A hexadecimal dump of the EPROM character generator that I use in Videographic to produce a customized display in the character mode. The first two digits of the PROM address is conveniently the ASCII equivalent of the character.

VIDEO CHAR	PROM ADDR	Rows of character dots 0	1	2	3	4	5	6	7	8	9	10	11				
	000	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-A	010	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-B	020	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-C	030	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-D	040	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-E	050	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-F	060	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-G	070	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-H	080	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-I	090	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-J	0A0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-K	0B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-L	0C0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
CNTL-M	0D0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
â	0E0	10	28	44	1E	22	42	42	46	3A	00	00	00	00	00	00	00
ê	0F0	10	28	44	3C	42	42	7E	40	3E	00	00	00	00	00	00	00
î	100	10	28	44	30	10	10	10	10	10	00	00	00	00	00	00	00
ô	110	10	28	44	3C	42	42	42	42	3C	00	00	00	00	00	00	00
û	120	10	28	44	42	42	42	42	42	3E	00	00	00	00	00	00	00
ä	130	00	66	00	1E	22	42	42	46	3A	00	00	00	00	00	00	00
ë	140	00	66	00	3C	42	42	7E	40	3E	00	00	00	00	00	00	00
ï	150	00	66	00	30	10	10	10	10	10	00	00	00	00	00	00	00
ö	160	00	66	00	3C	42	42	42	42	3C	00	00	00	00	00	00	00
ü	170	00	66	00	42	42	42	42	42	3E	00	00	00	00	00	00	00
ç	180	00	00	00	3C	42	40	40	42	3C	10	0C	18	00	00	00	00
°	190	3C	24	3C	00	00	00	00	00	00	00	00	00	00	00	00	00
§	1A0	1C	20	40	20	1C	14	1C	80	40	40	38	00	00	00	00	00
	1B0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
è	1C0	60	18	04	3C	42	42	7E	40	3E	00	00	00	00	00	00	00
é	1D0	06	18	20	3C	42	42	7E	40	3E	00	00	00	00	00	00	00
à	1E0	60	18	04	1E	22	42	42	46	3A	00	00	00	00	00	00	00
ù	1F0	60	18	04	42	42	42	42	42	3E	00	00	00	00	00	00	00
space	200	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
!	210	00	10	10	10	10	10	10	00	10	00	00	00	00	00	00	00
"	220	28	28	00	00	00	00	00	00	00	00	00	00	00	00	00	00
#	230	00	28	28	FE	28	FE	28	28	00	00	00	00	00	00	00	00
$	240	28	7E	A8	A8	7C	2A	2A	FC	28	00	00	00	00	00	00	00
%	250	00	42	E4	48	10	24	4E	84	00	00	00	00	00	00	00	00
&	260	70	88	88	50	20	52	8C	8C	72	00	00	00	00	00	00	00
'	270	18	08	10	00	00	00	00	00	00	00	00	00	00	00	00	00
(	280	02	04	08	08	08	08	08	04	02	00	00	00	00	00	00	00
)	290	40	20	10	10	10	10	10	20	40	00	00	00	00	00	00	00
*	2A0	00	10	54	38	FE	38	54	10	00	00	00	00	00	00	00	00
+	2B0	00	00	10	10	7C	10	10	00	00	00	00	00	00	00	00	00
,	2C0	00	00	00	00	00	00	00	00	30	10	20	00	00	00	00	00
-	2D0	00	00	00	00	7C	00	00	00	00	00	00	00	00	00	00	00
.	2E0	00	00	00	00	00	00	00	00	30	00	00	00	00	00	00	00
/	2F0	00	02	04	08	10	20	40	80	00	00	00	00	00	00	00	00
0	300	38	44	86	8A	92	A2	C2	44	38	00	00	00	00	00	00	00
1	310	10	30	50	10	10	10	10	10	7C	00	00	00	00	00	00	00
2	320	7C	82	02	04	18	20	40	80	FE	00	00	00	00	00	00	00
3	330	7E	04	08	10	3C	02	02	82	7C	00	00	00	00	00	00	00
4	340	08	18	28	48	FE	08	08	08	08	00	00	00	00	00	00	00
5	350	FC	80	80	80	FC	02	02	82	7C	00	00	00	00	00	00	00
6	360	7C	82	80	80	FC	82	82	82	7C	00	00	00	00	00	00	00
7	370	7E	42	02	04	08	10	10	10	10	00	00	00	00	00	00	00
8	380	7C	82	82	82	7C	82	82	82	7C	00	00	00	00	00	00	00
9	390	7C	82	82	82	7E	02	02	82	7C	00	00	00	00	00	00	00
:	3A0	00	00	00	18	00	00	18	00	00	00	00	00	00	00	00	00
;	3B0	00	00	00	00	18	00	00	18	08	10	00	00	00	00	00	00
<	3C0	00	04	08	10	20	10	08	04	00	00	00	00	00	00	00	00

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Listing 1 continued.

```
=     3D0   00 00 00 3C   00 3C 00 00   00 00 00 00   00 00 00 00
>     3E0   00 20 10 08   04 08 10 20   00 00 00 00   00 00 00 00
?     3F0   3C 42 42 04   08 10 10 00   10 00 00 00   00 00 00 00
@     400   00 3C 42 9A   AA AA 9C 40   3C 00 00 00   00 00 00 00
A     410   38 44 82 82   FE 82 82 82   82 00 00 00   00 00 00 00
B     420   FC 42 42 42   7E 42 42 42   FC 00 00 00   00 00 00 00
C     430   3C 82 80 80   80 80 80 82   7C 00 00 00   00 00 00 00
D     440   FC 42 42 42   42 42 42 42   FC 00 00 00   00 00 00 00
E     450   FE 80 80 80   F8 80 80 80   FE 00 00 00   00 00 00 00
F     460   FE 80 80 80   F8 80 80 80   80 00 00 00   00 00 00 00
G     470   7C 82 80 80   80 8E 82 82   7E 02 00 00   00 00 00 00
H     480   82 82 82 82   FE 82 82 82   82 00 00 00   00 00 00 00
I     490   7C 10 10 10   10 10 10 10   7C 00 00 00   00 00 00 00
J     4A0   3E 08 08 08   08 08 88 88   70 00 00 00   00 00 00 00
K     4B0   82 84 88 90   E0 90 88 84   82 00 00 00   00 00 00 00
L     4C0   80 80 80 80   80 80 80 80   FE 00 00 00   00 00 00 00
M     4D0   82 C6 AA 92   92 82 82 82   82 00 00 00   00 00 00 00
N     4E0   82 C2 A2 92   8A 86 82 82   82 00 00 00   00 00 00 00
O     4F0   7C 82 82 82   82 82 82 82   7C 00 00 00   00 00 00 00
P     500   FC 82 82 82   FC 80 80 80   80 00 00 00   00 00 00 00
Q     510   7C 82 82 82   82 82 8A 8A   8C 04 02 00   00 00 00 00
R     520   FC 82 82 82   FC 90 88 84   82 00 00 00   00 00 00 00
S     530   7C 82 80 40   38 04 02 82   7C 00 00 00   00 00 00 00
T     540   FE 92 10 10   10 10 10 10   10 00 00 00   00 00 00 00
U     550   82 82 82 82   82 82 82 82   7E 00 00 00   00 00 00 00
V     560   82 82 82 82   82 82 44 28   10 00 00 00   00 00 00 00
W     570   82 82 82 92   92 92 92 8A   44 00 00 00   00 00 00 00
X     580   82 82 44 28   10 28 44 82   82 00 00 00   00 00 00 00
Y     590   82 82 44 28   10 10 10 10   10 00 00 00   00 00 00 00
Z     5A0   FE 02 04 08   7C 20 40 80   FE 00 00 00   00 00 00 00
[     5B0   3C 20 20 20   20 20 20 20   3C 00 00 00   00 00 00 00
\     5C0   00 80 40 20   10 08 04 02   00 00 00 00   00 00 00 00
]     5D0   3C 04 04 04   04 04 04 04   3C 00 00 00   00 00 00 00
↑     5E0   00 10 38 54   10 10 10 10   00 00 00 00   00 00 00 00
      5F0   00 00 00 00   00 00 00 00   00 00 FE 00   00 00 00 00
      600   FE 82 92 8A   FE 8A 92 82   FE 00 00 00   00 00 00 00
a     610   00 00 00 1E   22 42 42 46   3A 00 00 00   00 00 00 00
b     620   40 40 40 58   64 42 42 62   5C 00 00 00   00 00 00 00
c     630   00 00 00 3C   42 40 40 42   3C 00 00 00   00 00 00 00
d     640   02 02 02 1A   26 42 42 46   3A 00 00 00   00 00 00 00
e     650   00 00 00 3C   42 42 7E 40   3E 00 00 00   00 00 00 00
f     660   0C 12 10 10   38 10 10 10   10 00 00 00   00 00 00 00
g     670   00 00 00 1A   26 42 42 46   3  02 42 3C   00 00 00 00
h     680   40 40 40 58   64 44 44 44   44 00 00 00   00 00 00 00
i     690   00 10 00 30   10 10 10 10   10 00 00 00   00 00 00 00
j     6A0   00 04 00 04   04 04 04 04   04 04 44 38   00 00 00 00
k     6B0   40 40 40 44   48 70 48 44   42 00 00 00   00 00 00 00
l     6C0   30 10 10 10   10 10 10 10   10 00 00 00   00 00 00 00
m     6D0   00 00 00 A4   DA 92 92 92   92 00 00 00   00 00 00 00
n     6E0   00 00 00 5C   62 42 42 42   42 00 00 00   00 00 00 00
o     6F0   00 00 00 3C   42 42 42 42   3C 00 00 00   00 00 00 00
p     700   00 00 00 58   64 42 42 62   5C 40 40 40   00 00 00 00
q     710   00 00 00 1A   26 42 42 46   3A 02 02 02   00 00 00 00
r     720   00 00 00 1C   52 60 40 40   40 00 00 00   00 00 00 00
s     730   00 00 00 3C   42 30 0C 42   3C 00 00 00   00 00 00 00
t     740   00 10 10 7C   10 10 10 12   0C 00 00 00   00 00 00 00
u     750   00 00 00 42   42 42 42 42   3E 00 00 00   00 00 00 00
v     760   00 00 00 44   44 44 44 28   10 00 00 00   00 00 00 00
w     770   00 00 00 82   82 92 92 92   θ  00 00 00   00 00 00 00
x     780   00 00 00 42   24 18 18 24   42 00 00 00   00 00 00 00
y     790   00 00 00 44   44 44 44 4C   34 04 44 38   00 00 00 00
z     7A0   00 00 00 7E   04 08 10 20   7E 00 00 00   00 00 00 00
—     7B0   00 00 00 00   FF 00 00 00   00 00 00 00   00 00 00 00
|     7C0   10 10 10 10   10 10 10 10   10 10 10 10   10 10 10 10
      7D0   00 00 00 00   00 00 00 00   00 FF 00 00   00 00 00 00
█     7E0   FF FF FF FF   FF FF FF FF   FF FF FF FF   FF FF FF FF
      7F0   00 00 00 00   00 00 00 00   00 00 00 00   00 00 00 00
```

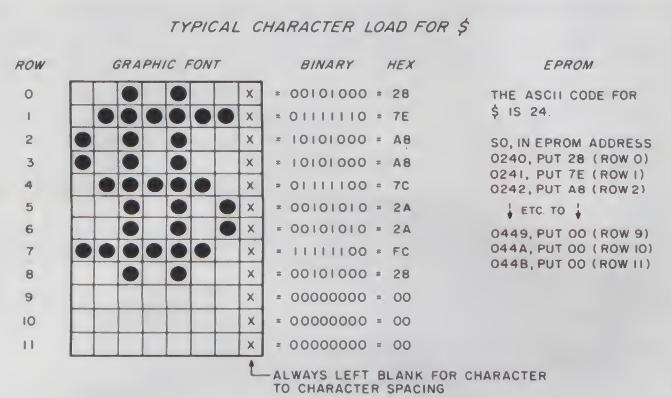

Fig. 2. Creating a character for your custom character generator. I used pennies to form the shape I wanted, then formed the eight-bit bytes across each row for a total of 12 bytes. The 6845 will call for this pattern row by row until the character is completely formed on the TV screen.

address. When the control logic on the memory board sees that the processor is requesting a valid S-100 bus address, it generates the BDSEL signal. The multiplexer switches the address from the processor to the memory instead of the address normally supplied by the 6845.

The processor can then read or write to that location. The memory output is probably not correct for the display at that moment, so a segment of a different character is substituted for the correct one, producing a snow effect if extensive updates are being performed. The snow can be eliminated by allowing the processor to access the shared memory only when the display is in the blanking cycle

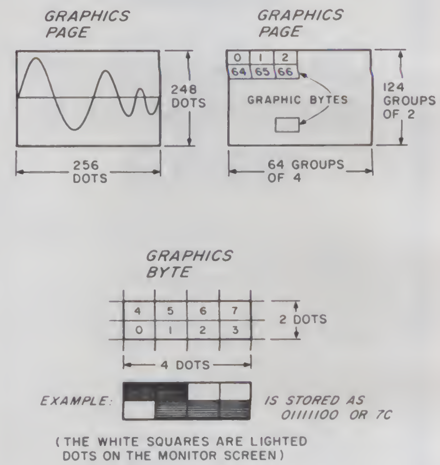

Fig. 3. Formation of a graphics mode character.

- 80 characters in 24 lines in the character mode. High-resolution 256 by 248 bits in the graphics mode.
- Custom-designed characters available in an 8 by 12 format. Seventh column blanked. User programmable in EPROM.
- Compatible with 4 MHz processors. Memory-mapped video. Requires 8K static RAM. (2K for character mode only.)
- Based on MC6845 Video-Display Generator. Easily programmed to support any screen format. Interfaces to host processor via I/O ports. Produces video signal to a monitor or modified television.
- Supported by high-level graphics subroutines to produce designs efficiently.
- Software driver recognizes:
—ASCII characters, upper and lowercase
—Control characters: line feed, carriage return, back space, bell
—Cursor control codes (with scrolling capability): cursor up, down, right, left and home
- Light pen capability.

Table 1. Summary of the characteristics of the Videographic board.

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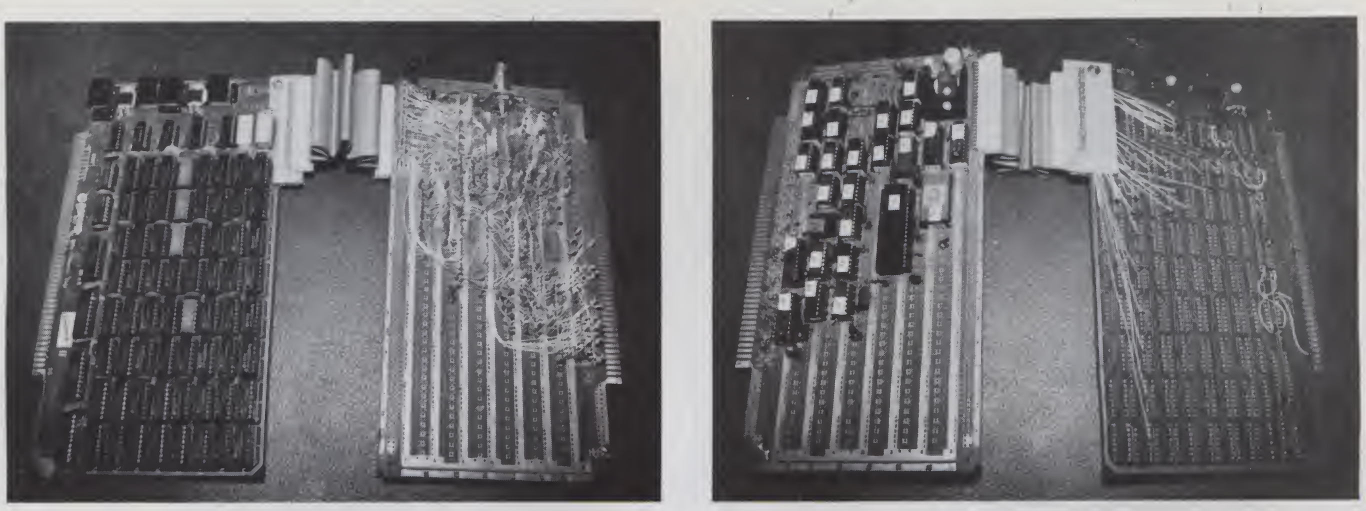

Photos 2 and 3. The front and back views of the Videographic display board and its shared static RAM memory. This dependable board, called the Econoram II from Godbout was the author's first and only RAM memory. Now it easily serves as the memory-mapped video.

during the horizontal or vertical retrace, but I have not included the software in my design. (The blanking signal is available at bit zero on the status input port.)

A status flip-flop determines the current mode, character or graphic. This D-type flip-flop is accessed by a processor output command. The graphics mode will alter the circuit operation slightly: the dot clock frequency is divided by two, and the character generator EPROM is bypassed by a two-to-one multiplexer. After reprogramming the 6845 for a 64-character by 124-line display (which happens in milliseconds), you have a high-density graphic display.

As shown in Fig. 3, each dot on the screen matches to a bit in memory. A byte is split in a 4×2 matrix. The total screen density is a pleasing 256 dots across by 248 dots down, better than most ready-made microcomputers on

the market today. Photo 5 shows some sample designs. The software to create those dots is included later in this article, and can be used by both machine-language and higher-level programs.

6845 Interface to the Processor

As you already know, the characteristics of the video display are set by values stored in the 6845's internal registers by an initialization routine run by your processor. Nineteen registers in the 6845 can be accessed by means of the S-100 data bus. These registers and their characteristics are shown in Table 2.

Some of the registers are written only at system reset or character/graphic mode changes to establish display format. Others are updated periodically as part of normal operation (scrolling and cursor functions). Several fine discussions have appeared in *Microcomputing* and other magazines that explain the operation of the 6845 at length (see References).

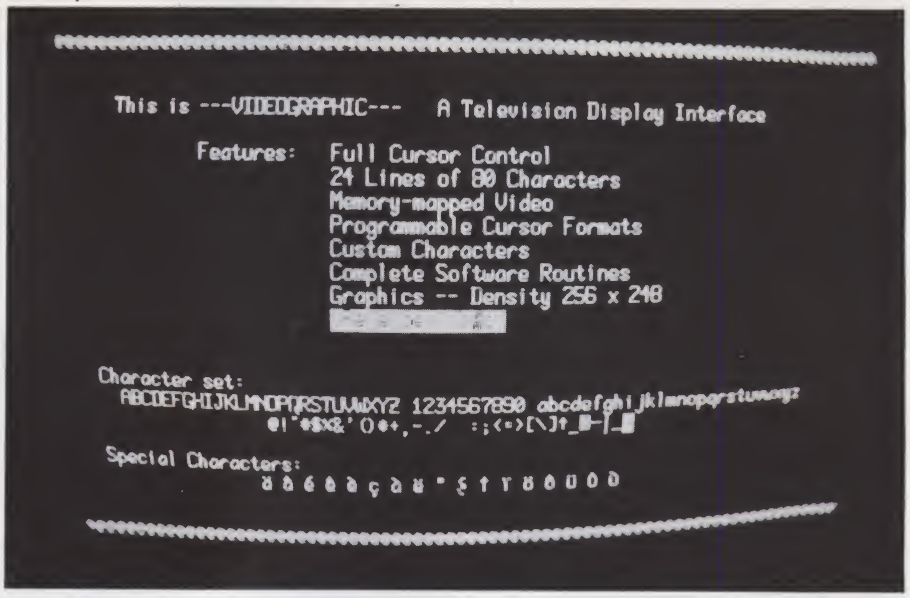

Photo 4. This picture, taken while in the character mode, shows a representative sample of the Videographic character set as programmed in the 2716 EPROM. You can change the shape of the characters as you desire, or create your own set. It was surprisingly easy—and fun—to invent the character set.

For your system to access the 6845's internal registers, you need to generate certain signals: Chip Select ($\overline{CS}$), Enable, Register Select (RS) and Read/Write (R/$\overline{W}$). Your circuit must create these signals within the 6845 minimum timing specifications. I have

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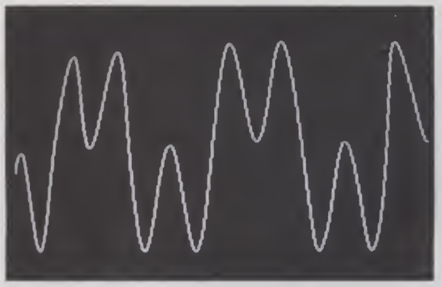

Photo 5. These are simple geometric designs drawn by Videographic while in the graphics mode. They show the flexibility of this nearly 8K bytes (63,488 bits) display. Software in Listing 2 will plot or unplot dots, as well as draw straight lines between any two points you specify in a calling program.

implemented a satisfactory interface with a 4 MHz bus operation as shown by the waveforms in Fig. 4. Note that the 6845 specifications are met. If your processor is slower than 4 MHz, you may be able to eliminate the wait states and the PRDY signal.

Table 2 shows that the address register is a five-bit write-only register used as an indirect or pointer register. Its contents are the address of one of the other 18 registers on the chip. When RS is low, the address register itself is addressed. When RS is high, the register file pointed to be the address register is accessed. In other words, to write to any particular register file, two output cycles must occur; one to point to that register file, and the other to read/write data in it.

The RS line is connected to the system address line 0 (the least significant bit), so the two output ports to change a register file will have consecutive addresses. (In my design, I/O ports 70H and 71H.) The routines to initialize and maintain these registers are part of the software listing presented here.

I decoded two more addresses so that I could change the Videographic mode from character to graphics and back, as well as input the status of the light pen and blanking signals. All addresses are detailed in Table 3.

6845 RS	Register Number	Register File Name	Program Unit	# of Bits	Read ?	Write ?
0	—	Address Register	—	5	No	Yes
1	R0	Horizontal Total	Char.	8	No	Yes
1	R1	Horizontal Displayed	Char.	8	No	Yes
1	R2	H. Sync Position	Char.	8	No	Yes
1	R3	H. Sync Width	Char.	4	No	Yes
1	R4	Vertical Total	Row	7	No	Yes
1	R5	V. Total Adjust	Scan Ln.	5	No	Yes
1	R6	V. Displayed	Row	7	No	Yes
1	R7	V. Sync Position	Row	7	No	Yes
1	R8	Interlace Mode	—	2	No	Yes
1	R9	Max Scan Length Address	Scan Ln.	5	No	Yes
1	R10	Cursor Start	Scan Ln.	7**	No	Yes
1	R11	Cursor End	Scan Ln.	5	No	Yes
*1	R12	Start Address (H)	—	6	No	Yes
*1	R13	Start Address (L)	—	8	No	Yes
*1	R14	Cursor (H)	—	6	Yes	Yes
*1	R15	Cursor (L)	—	8	Yes	Yes
*1	R16	Light Pen (H)	—	6	Yes	No
*1	R17	Light Pen (L)	—	8	Yes	No

Table 2. The MC6845 internal register descriptions. The values marked by an asterisk may be updated during regular use. The position marked by two asterisks is explained at length in the text.

Input/Output Address	IC40 pin	Input Function	Output Function
60 (xx1000x0)	Y1	Not Used	Change to Graphic Mode
61 (xx1000x1)	Y2	Video Board Status	Change to Character Mode
70 (xx1100x0)	Y5	Not Used	6845 Register Select
71 (xx1100x1)	Y6	6845 Register Read	6845 Register Write

Table 3. Input and output addresses are decoded by IC40, a 74LS138. It is a 3 to 8 decoder. Videographic uses only its $\overline{Y1}$, $\overline{Y2}$, $\overline{Y5}$ and $\overline{Y6}$ outputs. The x's in the address are don't-cares, and are assumed to be (01----0-) in Videographic.

TV Monitor and Light Pen

I used the popular Leedex Video 100 as a monitor. It can be purchased from most mail-order outlets from \$129 to \$150. It is a good buy—it offers great bandwidth for the Videographic board and easy operation. If you intend to use an adapted TV receiver, it must have about a 6 MHz bandwidth to work without signal loss.

If you plan to use a TV with severe overscan, as most nonmonitor TV sets are designed to have, use a slightly faster clock rate. A 14 MHz clock will let you program the 6845 with the same page size, but give you more time for vertical and horizontal blanking so that you can correct for TV screen overscan. When changing the dot and character *clock frequency*, you will have to modify the register file data somewhat to account for the higher clock rate and maintain the same screen update timing.

Implementing the light pen hardware is easy. The +12 V I needed for the circuit came right from the power-on LED board in back of the monitor. The monitor offered a convenient spot to mount the components, and the front panel of the TV had two spots perfect for the miniature phone plug and sensitivity control. The signal is sent to the video board where it is buffered and used by the 6845 and the S-100 bus. Photos 6a and 6b show my version of the light pen components.

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You can construct your own light pen with an old pen cartridge and phototransistor. However, I elected to buy a light pen for $20 from 3-G Company, Inc., Dept. KB, Route 3 Box 28A, Gaston, OR 97119. As it sees the electron beam when held close to the screen, the high signal at LPSTB on the 6845 will latch the current address of the character in file registers R16 and R17. The processor can then access these two registers to determine the location to which you are pointing the light pen. The necessary software, although not exactly trivial, is straightforward and will not

Photo 6a. *The front panel of the Leedex Video 100 modified for light pen use.*

Photo 6b. *The transistor interface that I designed to support the light pen feature fits easily on a small breadboard layout. One night's construction was all that was necessary to assemble it and mount it as you see in this picture. The +12 V I needed for the circuit was conveniently available from the power-on LED board nearby.*

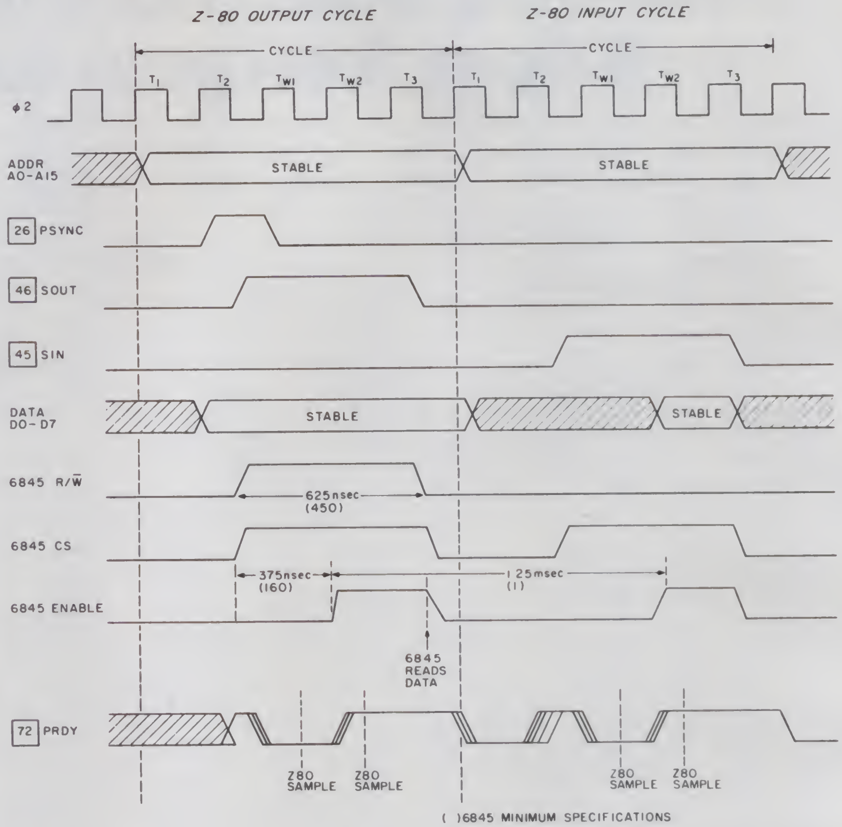

Fig. 4. *The processor interface waveforms. The circuitry was designed to avoid exceeding any of the 6845 timing specs. All specs are minimums and are shown in parentheses.*

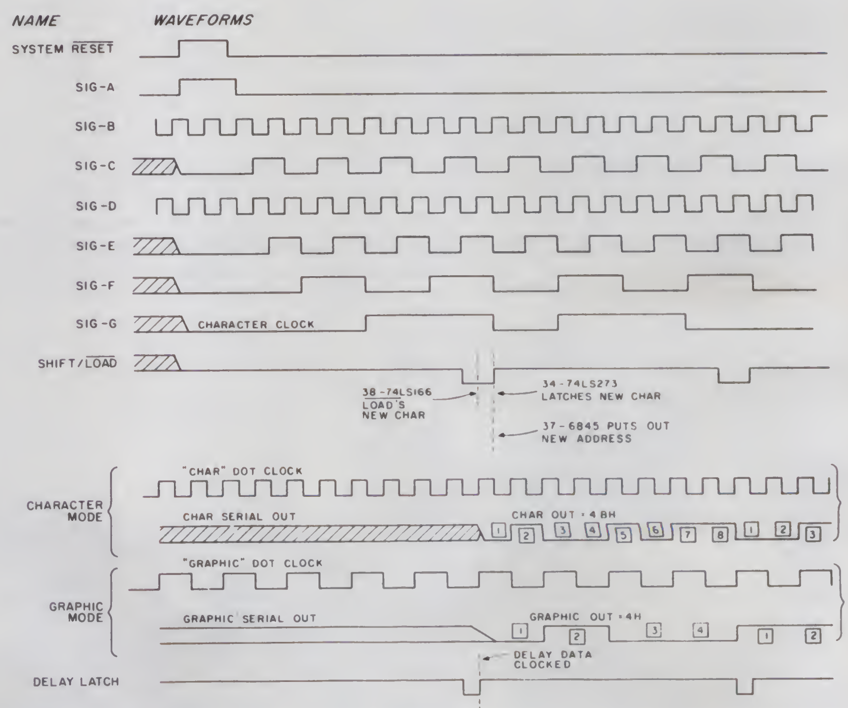

Fig. 5. *These are the waveforms associated with the creation of a video character. SIG-A is derived so that the dot clock timing will have proper phase relationship to the SHIFT/LOAD signal when a reset pulse occurs.*

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be discussed further.

The Two-Character Delay

The sequence of character operations is as follows:

The 6845 presents a character address for the screen update to the memory. The memory after a set-up delay presents the character to the latch, IC34. The character in IC34 is then presented to the character generator, IC37, or to the graphics multiplexer, IC33, depending on the mode selection. The dots for the specified scan row of the character are then presented to the shift register, IC38, and shifted out at the dot clock rate to produce the video signal. Fig. 5 shows the timing of this sequence for the character and the graphic modes.

Because of the set-up time delays in the memory, two characters are actually being processed at any one time—one character being accessed from the shared memory, and one character being output by the character generator or graphic multiplexer to the shift register. (Actually, the second character is one row of dots, not the whole character.) Thus, the two 6845 signals, cursor and display enable, must be delayed two character inter-

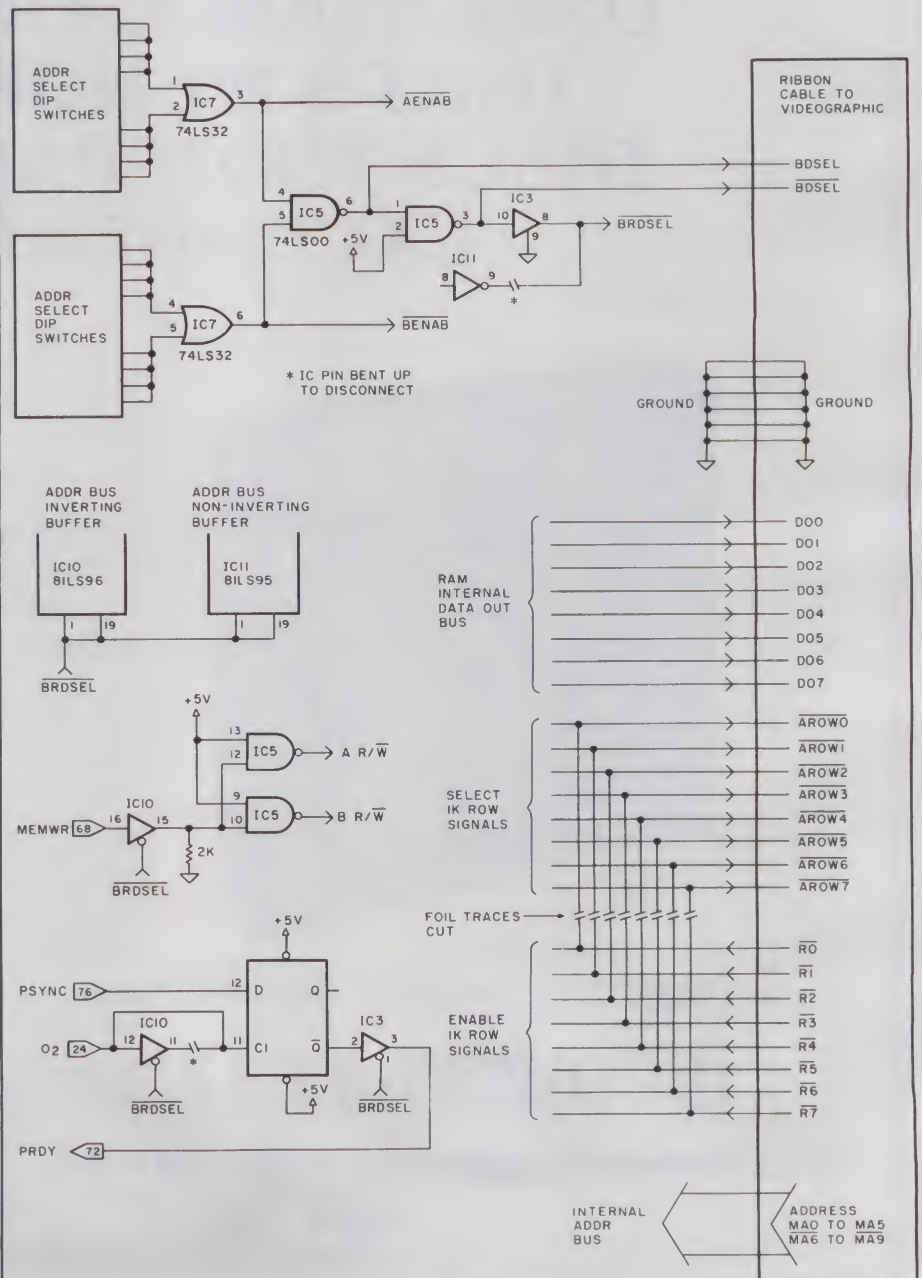

Fig. 6. The simple changes made to the 8K static RAM board. The intercepted signals were routed to the Videographic board over the ribbon cable.

vals by IC44 to accommodate this delay effect.

Cursor Generation

The cursor signal is true whenever the 6845 output address matches the internal value in the cursor address register pair (R14 and R15). This signal is processed in such a way with bit 7 of the incoming character byte (the bit that determines the black-on-white status of the video) so that the 6845 cursor signal will always cause a reversal of the character.

The cursor can be programmed to underline, reverse the entire character, slow blink, fast blink or stay on steady. Registers R10 and R11 control the format of the cursor, and R14 and R15 control its position. The low-order five bits of R10 (bits 0 through 4) specify the scan row on which the

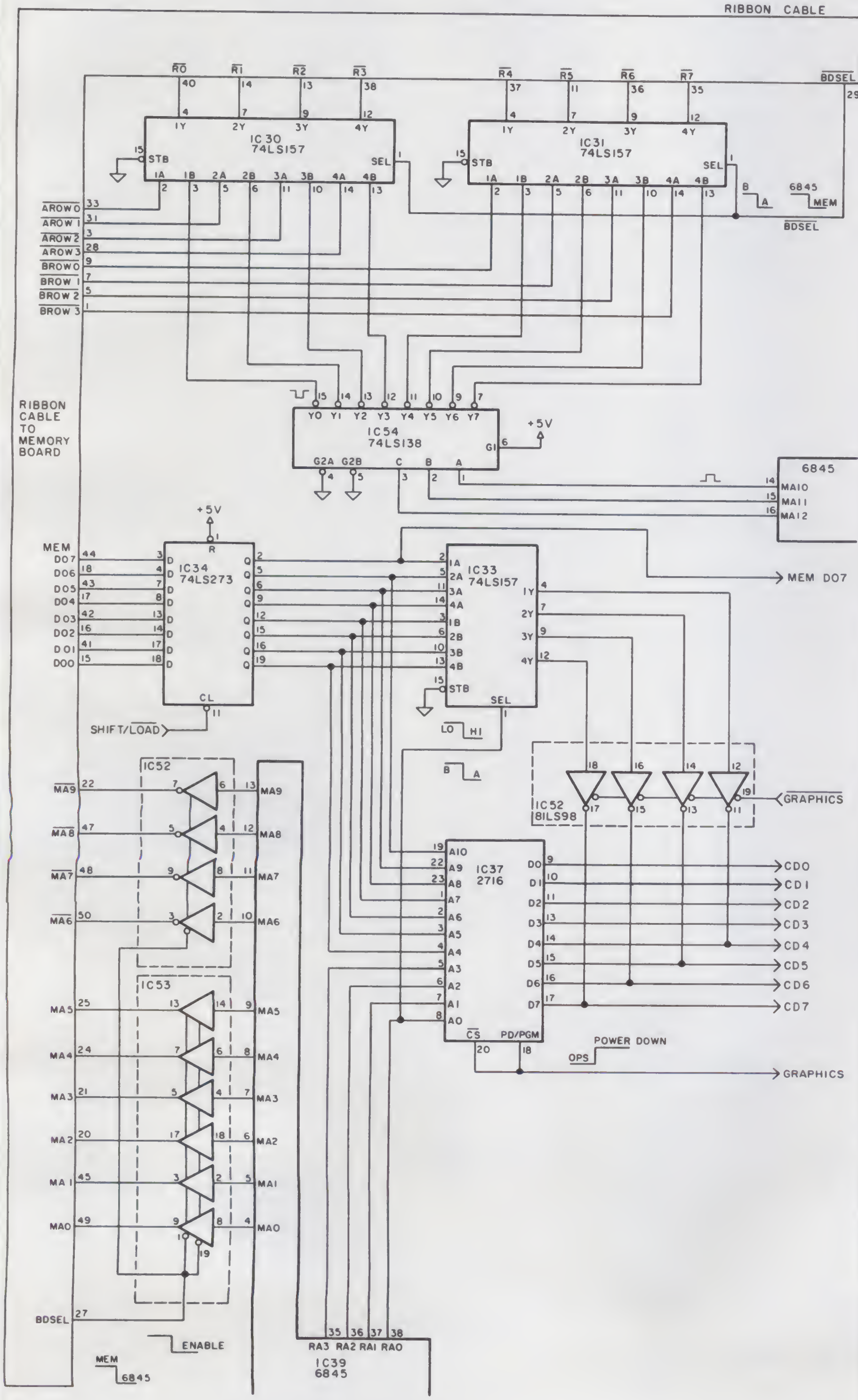

Fig. 7. The complete schematic for Videographic.

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cursor is to start; the R11 specifies the scan row on which the cursor is to end. If R10 bits 0 through 4 are all equal to 0, and R11 is 11, the cursor will occupy lines 0 through 12, or the entire character. The character is reversed. If the value of 10 is stored in R10 bits 0 through 4, the cursor becomes a two-line underscore. This is what I prefer.

Bits 5 and 6 of R10 determine cursor blinking. If bit 5 is on and bit 6 is off, the cursor is not displayed at all. You can use this to blank the cursor for graphic display or other uses. If bit 6 is on, the cursor will blink. If bit 5 is off, the blink rate is about four times a second. If bit 5 is on, the blink rate is two times per second.

The Memory Board

Fortunately, all the devices I needed to make Godbout's 8K Static Econoram II share memory with the Videographic could come on unused components right from the board. Fig. 6 shows the components changed to interrupt the data and address signals, and produce the BDSEL and $\overline{\text{BDSEL}}$ for the video board to use. Since the 21L02 chips are arranged in 1K rows, the Godbout board decodes the addresses into eight row-enable signals. I cut those traces and routed

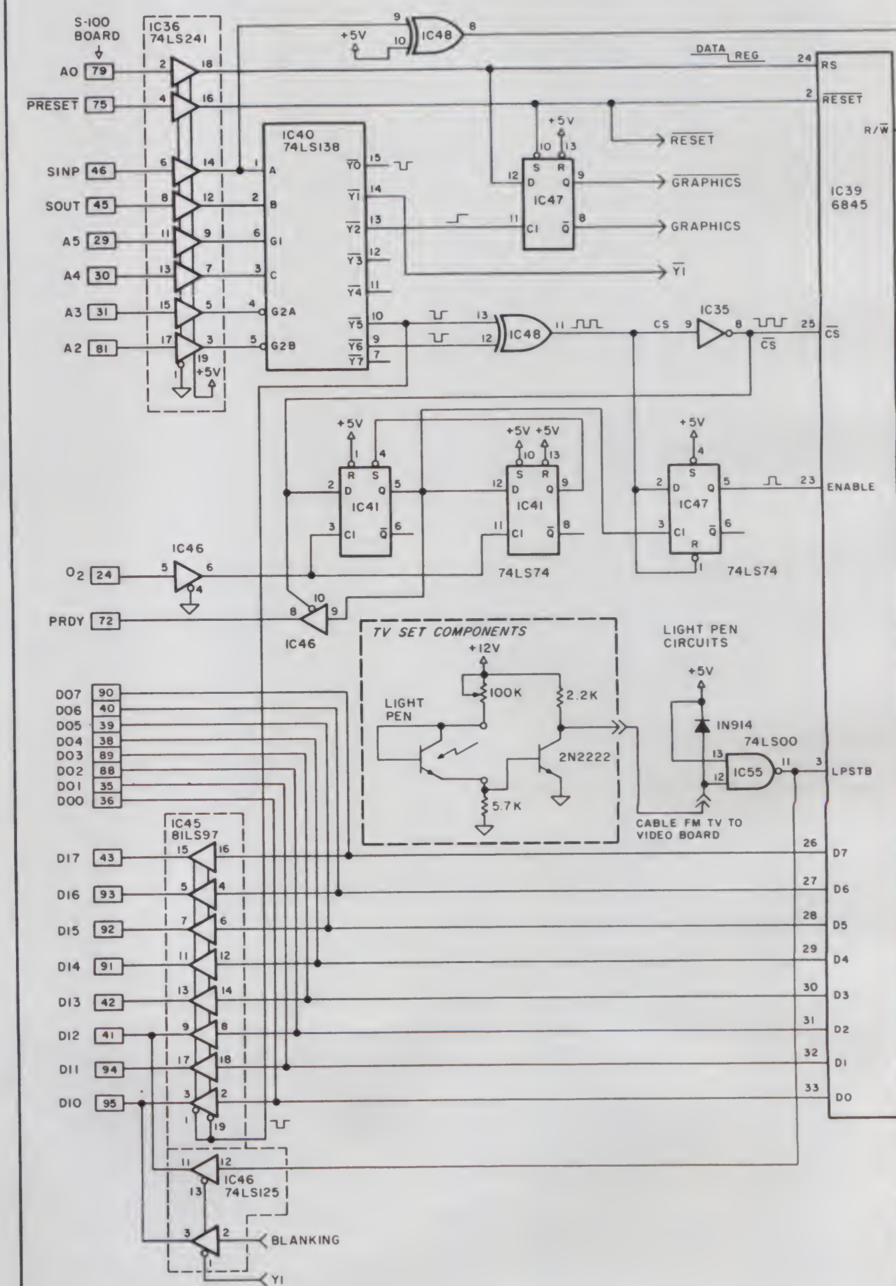

Fig. 7b.

those signals over the ribbon cable to IC30 and IC31.

These chips also get eight decoded row-enable signals from the 6845 address lines MA11, MA12 and MA13. Normally, 6845 row-enable signals get through until the Econoram is accessed by the processor. At that time, BDSEL goes low, and the Econoram row-enable signals are routed through IC30 and IC31 back through the ribbon cable to the memory chip-enable lines on the proper row.

To get the memory output, I merely tapped the data-out bus on the Econoram, and routed it over the ribbon cable to IC34, the eight-bit latch.

If you desire to use 2114 static RAMs on the Videographic board, you will have the advantage of lower power requirements and fewer memory chips, 16 instead of 64. (You also have the option to wire up only 2K as memory, but be aware that you will then have no graphics capability. However, a whole video display of characters with the minimum of two 2114s will be available to you. At $6 apiece, low memory costs.)

Construction

Fig. 7 provides the complete schematics for Videographic. As I noted in the block diagram, the 6845 is the central chip of the circuit. Photo 7 shows my prototype, and there is enough room left over for on-board memory, or expansion to a keyboard input interface. I used the excellent 8804 breadboard from Vector Electronics Company (12460 Gladstone Ave., Sylmar, CA 91342). The chips are labeled starting at IC30, merely because other hobby boards in my computer have already used the first 29 labels.

Wire-wrapping is the only means for a hobbyist to connect this system together. I used the Just Wrap tool (from OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475) for point-to-point wire-wrapping; it is far superior to other alternatives when wire-wrapping on a large scale. Watch out though—no matter how much experience you've had, a small percentage of wrappings will always turn out bad. So double-checking with a circuit tester after wrapping is an absolute necessity.

Photo 8 shows the reverse side of the Videographic board. Note that the wires appear neat and taut.

This brings us to the actual construction. There is plenty of good advice in the magazines these days on how to construct an electronic project. (Don Lancaster's *TTL Cookbook* has a good set of tips.) I want to pass along some heartfelt rules that I have

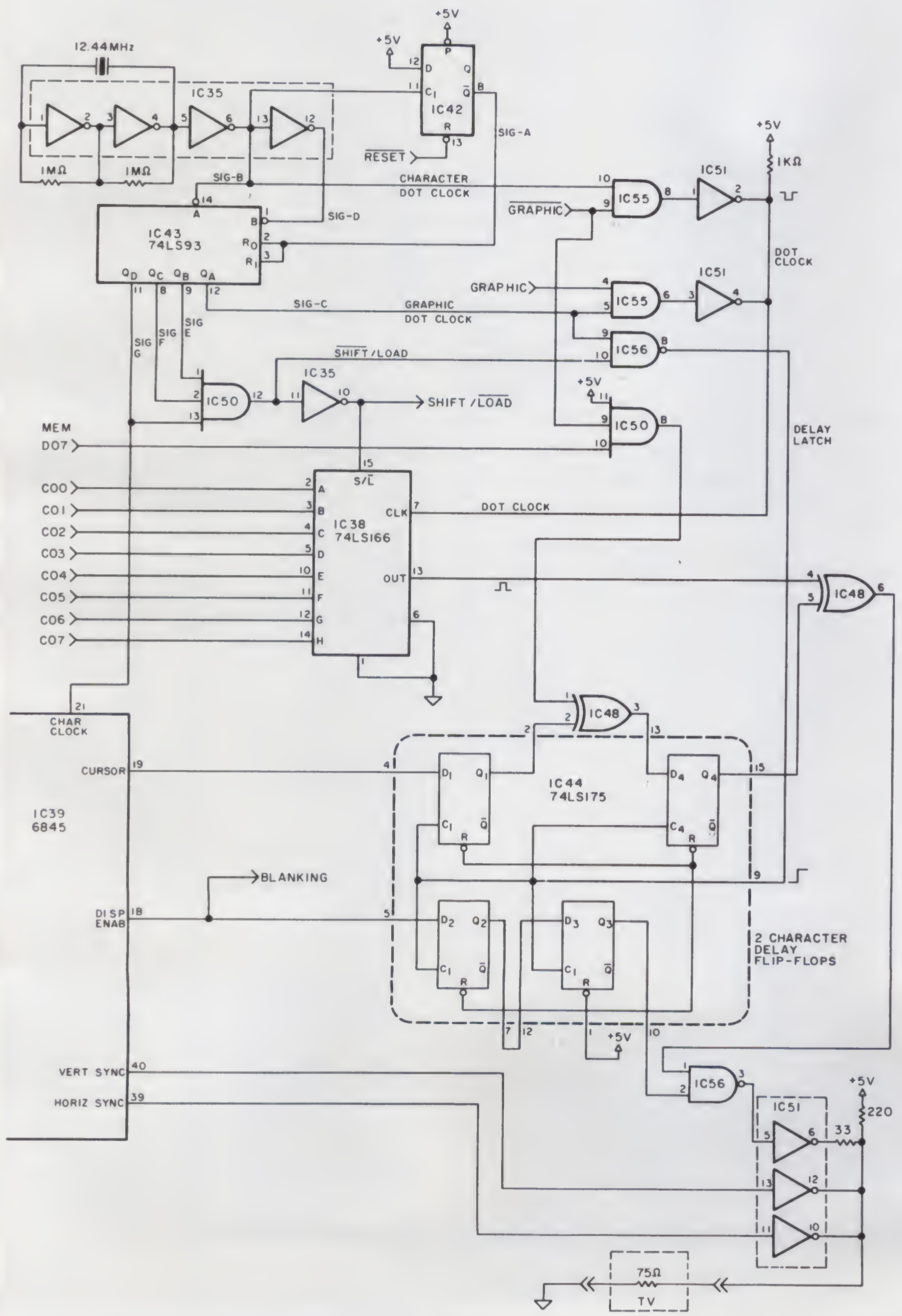

Fig. 7c.

IC	Type	Pins
30	74LS157	16
31	74LS157	16
33	74LS157	16
34	74LS273	20
35	74S04	14
36	74LS241	20
37	2516 EPROM	24
38	74LS166	16
39	6845	40
40	74LS138	16
41	74LS74	14
42	74LS74	14
43	74LS93	14
44	74LS175	16
45	81LS97	20
46	74LS125	14
47	74LS74	14
48	74S86	14
50	47S11	14
51	74S05	14
52	81LS98	20
53	81LS97	20
54	74LS138	16
55	74LS09	14
56	74LS00	14

Fig. 7d. IC listing.

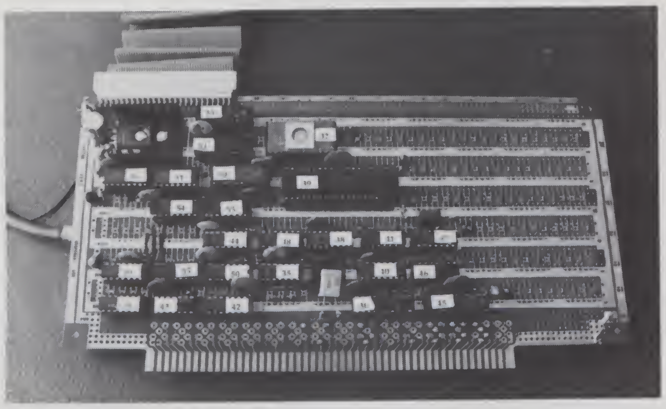

Photo 7. *The complete Videographic video board is shown in this close-up component view. Note that there are plenty of despiking capacitors, and that there is enough room left on this prototype for onboard static memory if desired. The numbers on the chips correspond to the IC numbers used throughout this article.*

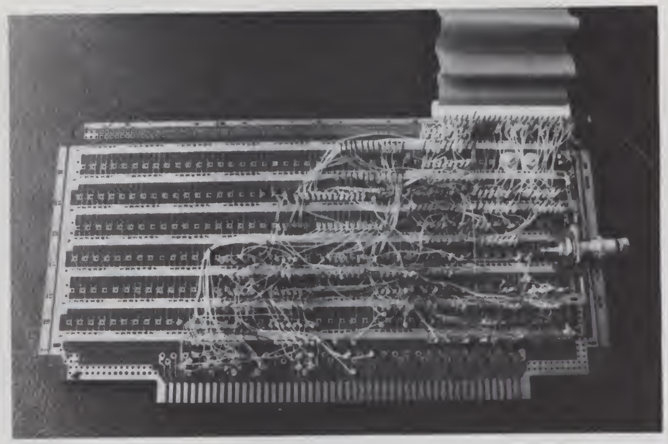

Photo 8. *The bottom, or wire-wrapped, side of the video terminal board. Neatness counts, and saves you hours of troubleshooting later. The video cable plugs into a socket that is exposed to the board. All high-frequency wire runs are kept as short as possible.*

learned the hard way.

- Capacitors, capacitors, capacitors! Use plenty of them. I try to get almost one .1 uF disk capacitor per TTL chip. Keep the leads as short as possible. Put a 10 uF tantalum at the output of the regulator, and a 1 uF tantalum at the end of each chip row. Watch those polarities! This practice is especially important at the clock speeds in Videographic.
- It is impossible to avoid errors in wire-wrapping, so Xerox a copy of your schematic. Make the connection. Test it. Then mark it off with a colored pencil on the schematic. Sound easy? It is, if you want to avoid hours of headaches later. You'll be surprised at the number of connections you will do over. When the board is complete, test each line again and mark it off on the schematic. It saves hours.
- Use epoxy to cement the sockets to the board. Keep the fastest chips close together, and the 12 to 14 MHz wire runs as short as possible. Line up all the chips in one direction so that the 1 pins are always in the same corner. Make no exceptions.
- Wire all ground wires first, then all +5 V supply lines. Use many colors of wire to help later troubleshooting or modifications.
- Don't have wires too loose. Keep them close to the board, thereby close to the ground plane. Do all soldering before starting to wire-wrap.
- Power up the board before plugging in any chips to check the supply regulator performance. It makes sense to smoke-test the regulator first so one doesn't risk all the IC chips.
- This is the last bit of advice, and it is the hardest to live by. Document whatever wiring changes you make on your schematic. Do not ever leave your project for the day without writing your changes down neatly.

If you have been meticulous, Videographic will start to work the first time you plug it in. (Remember, the 6845 will have to be programmed before it operates the way you want it to.)

Troubleshooting a system without good tools is almost impossible. Although a limited test circuit is built in (the actual display), you may have to use an oscilloscope to test further. Logic testers will help you to hunt down small problems. Use the waveforms in Fig. 5 to track the signals from the crystal oscillator to the various clocks. If those check out, verify proper operation of the memory (write and read to it), and the interface to the 6845 (run little software output loops while checking 6845 control signals). Kick yourself if you find that the bug turns out to be a wire-wrap error. You were warned. Photo 9 shows some of the growing pains while Videographic was being debugged.

Software Driver

Table 4 lists the available control codes to operate the driver. The Videographic software driver is contained in Listing 2. I have used my own assembler to create the listing, but most of the conventions found in commercial assemblers are present. The program is written in Z-80 object code starting at 1030 hex. It has four sections:

1. Routines for character loading and cursor control.
2. Subroutines for section 1 and

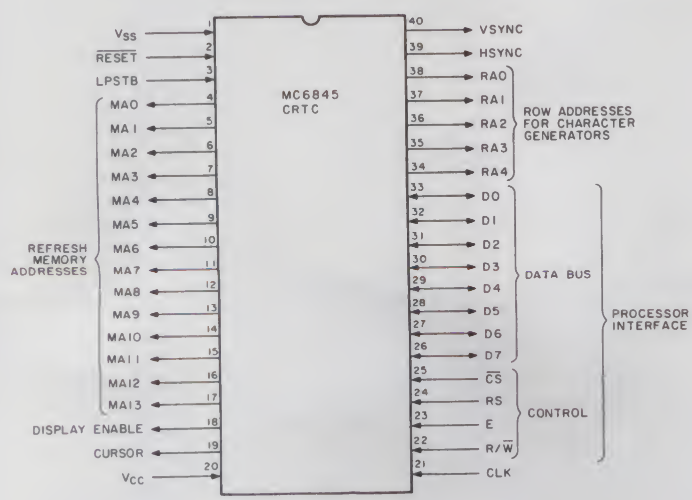

Fig. 8. The Motorola MC6845 pin-out. A prospective user of this chip should obtain a copy of its technical specs. See the article for details.

Photo 9. *Troubleshooting a new circuit can be half the fun of construction. Here, the video logic is going through some growing pains.*

outside program use.

3. Initialization routines for the character and graphics modes.

4. Routines for drawing and undrawing dots in the graphics mode. An algorithm to draw lines between any two points on the screen is included to speed up the larger routines to improve overall speed.

A buffer area of 15 bytes must be set aside for the Videographic in a memory area. (I use BFF0 to BFFF.) I designed the software so only two bytes need to be altered to relocate this buffer area. That is why I make such extensive use of the IX register throughout the subroutines.

Actual memory displayed in the character mode is 80 × 24 characters, or 1920 bytes. The starting point in the 8K RAM could be anywhere, depending on the contents of the 6845 register files R12 and R13. Changing these two registers will scroll the screen for the user.

When in the 256 × 248 graphics mode, memory displayed is much more—64 times 124, or 7936 bytes. That is 63,488 bits of memory used, or 63,488 potential dots on the screen. R12 and R13 register files will stay at zero at all times in the graphics mode.

Scrolling

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character, line or by page simply by starting its update cycle on a different memory address. The software presented here scrolls line by line. The principle is simply that new data is entered on the bottom line of the display. When the bottom line is full, the entire display is moved up one line. In the process, the top line, containing the oldest data, is scrolled off the screen. The display can be scrolled down as well as up, and the TV screen acts as a movable window. The driver program changes the update start address of the 6845 in increments of 80 (for the 80-character line width).

When the scrolling process completes several video pages and comes to the end of the memory-mapped 8K, a wrap-around occurs—the address 8192 is equivalent (at least from the point of view of the 6845) to the address 0. Thus, the wrap-around occurs automatically, even if it occurs in the middle of the screen.

Note, however, that the 6845 can address up to a full 16K of memory. I use only 13 bits of the 14-bit address. I leave the most significant bit of the 6845 address disconnected. But the cursor address register, light pen address register and the update address register are 14-bit registers. All 14 bits must match a displayed video character to expect proper operation. This fact, when overlooked, can cause problems when you are writing your own driver routines. Be especially wary when wrap-arounds occur in the middle of a page.

ASCII Code	Name	Function
07	Cntl-G	Rings the terminal bell.
08	Cntl-H	Backspace. (Cursor Left)
09	Cntl-I	Cursor up.
0A	Cntl-J	Line feed. (Cursor Down)
0B	Cntl-K	Cursor forward.
0C	Cntl-L	Cursor home (upper left corner).
0D	Cntl-M	Carriage return.

Table 4. Software driver commands.

Register	Function of Register	Characters 80×24	Graphics 256×248
R0	horizontal total	102 (66)	102 (66)
R1	horizontal columns displayed	80 (50)	64 (40)
R2	horizontal sync position	86 (56)	78 (4E)
R3	horizontal sync width	12 (0C)	9 (09)
R4	vertical total	24 (18)	127 (7F)
R5	vertical total adjustment	19 (13)	25 (19)
R6	vertical rows displayed	24 (18)	127 (7F)
R7	vertical sync position	24 (18)	125 (7D)
R8	interlace mode	0 (0)	0 (0)
R9	maximum scan line	11 (0B)	1 (01)
R10	cursor start	73 (49)	0 (0)
R11	cursor end	11 (0B)	0 (0)
R12 through R17	cursor and RAM start	0 (0)	0 (0)

Table 5. Appropriate MC6845 values to be stored in the internal registers for the character and graphics display formats. The values given are for a 12.440 MHz crystal dot clock. The decimal value is given, followed by the hexadecimal equivalent in parentheses. If you need a faster clock, some of these registers have to have different values. (For example: 14.138 MHz crystal, R0 must be set to 70 hex, R2 must be set to 5A hex character mode and 52 hex for graphics mode.)

Listing 2. The Videographic software driver. *(Listing continues on page 163.)*

```
0000          1 ORIG 0
0000        100 ;**********************************************
0000        110 ;*** VIDEOGRAPHIC DRIVER SOFTWARE   ***********
0000        120 ;**********************************************
0000        130 ;*** WRITTEN BY J.J. MARTINKA ****************
0000        140 ;*** OCTOBER, 1980            ****************
0000        150 ;**********************************************
0000        160 ;
0000        170 ;THIS DRIVER FACILITATES THE USE OF THE VIDEO-
0000        180 ;GRAPHIC BOARD AS A CONSOLE DISPLAY DEVICE.
0000        190 ;IT IS PRESENTED AS FOUR SECTIONS:
0000        200 ; 1) THE ROUTINES CALLED FOR CHARACTER LOADING
0000        210 ;    AND CURSOR CONTROL
0000        220 ; 2) SUB-ROUTINES USED BY SECTION 1) AND ARE
0000        230 ;    ACCESSIBLE FOR OUTSIDE PROGRAM USE BY
0000        235 ;    TEXT EDITORS OR OTHER PROGRAMS
0000        240 ; 3) THE INITIALIZATION ROUTINE NEEDED PRIOR TO
0000        250 ;    6845 VIDEO CHIP OPERATIONS
0000        260 ; 4) SHORT GRAPHICS ROUTINES
0000        270 ;
0000        280 ; NOTE: THIS PRESENTATION IS ASSEMBLED BY A HOME
0000        290 ; BREW ASSEMBLER, AND ITS OUTPUT IS FREE FORMAT.
0000        300 ; THE ONLY REAL DIFFERENCES FROM COMMERCIAL
0000        305 ; ASSEMBLERS ARE:
0000        310 ;   -LABELS ARE ASSIGNED WITH THE COLON IN FRONT
0000        320 ;      INSTEAD OF BEHIND.   I.E.  20   :ECHO  NOP
0000        330 ;   -JP, JR, AND CALL INSTRUCTIONS THAT HAVE
0000        340 ;      CONDITIONS ARE PRECEEDED BY A PERIOD.
0000        350 ;      I.E.  CALL .NZ,ADDRESS       JR .C,ADDRESS
0000        360 ;
0000        370 ;
```

More

Conclusion

I hope Videographic will interest you as much as it did me. It is a complete video system, and will keep you busy for months with its many possibilities.■

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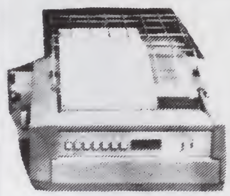

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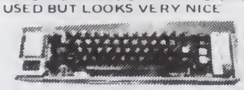

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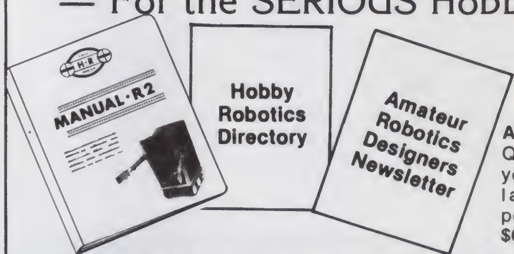

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Editor's Corner

The Shiny Apple

By Harold Nelson
***Microcomputing* Technical Editor**

In the five years since two young men started building *microcomputers* in a garage in California, Apple Computer, Inc., has become, according to *The Wall Street Journal*, "one of the hottest high-technology companies to go public." Among computerists, it is also one of the microcomputer industry's most respected manufacturers. The Apple II itself is one of the chief reasons why—it's a sound computer, easily adapted to virtually any purpose. Also, Apple encourages independent producers to develop products for use with its computers, a philosophy that lets users easily modify their Apples when they need to.

Applefest '81

In spite of early difficulties with the new Apple III computer, consumer interest in, and enthusiasm for, Apple seems to be undiminished. June's highly successful Applefest '81 show (10,000 paid attendance), sponsored by the Apple/Boston group of the Boston Computer Society, underlined this point. Even though the temperature was close to 90 degrees, with the humidity not far behind, both spirits and exhibitor sales were high. The show was not only well-supported by current and potential Apple owners; Apple Computer itself was well-represented. They provided a public hands-on room with about 20 Apple IIs, and offered free 45-minute "lessons" on 15 Apple IIIs. It wasn't easy to find a computer in either of these rooms that was not being used.

Apple III, Round 2

The Apple announced its Apple III well over a year ago (May 1980, to be specific). Orders were enthusiastically placed and received. Then the long wait began.

Prior to March of this year, only some 1000 Apple IIIs were delivered—many months behind the first scheduled delivery dates. The machines only became readily available this spring.

Soon after the first Apple IIIs were out, horror stories began to appear. These ranged from reports of minor problems to statements that the machine was a total failure and that Apple would not be able to reproduce its success with the Apple II. Rumors began to circulate that the company itself was in trouble.

The Apple III had some very real problems, but it now appears that the doomsayers were a little hasty. Obviously, Apple released the Apple III prematurely. Phil Roybal, Apple's Product Marketing Manager, does not shy away from discussing these problems, which included:

- Intermittent difficulties with programmable random-access memory. Apple discovered that corrosion formed on memory board contacts after the computers were shipped. Coating these contacts with a protective lubricant at the factory has eliminated the problem.
- In shipment, ICs worked out of their sockets, a result of movement of the large motherboard and loose sockets. The solution was to use tighter sockets with a metal tab to hold the ICs in place.
- The tighter sockets did not seem to remedy the above problem. Actually, the new sockets caused new problems with similar symptoms to those caused by the loose sockets. The new sockets were so tight that

The Apple III features an 80-character, upper and lowercase display, up to 128K of memory, one built-in disk drive and the capacity for more. (Computer courtesy of Computer Town of Salem, NH)

Applefest '81 in Boston was hot, humid, crowded and a huge success.

pins were often bent when the ICs were installed. Apple didn't detect this at first, since the tabs tended to cover up the problem during factory testing. The final solution was to use the tighter sockets without the tabs. Now bent pins can be detected during factory inspection.

- The very fine-line PC board first used in the Apple III made it hard to detect slight solder bridges occurring during assembly. Apple has lessened this problem by using wider traces on the PC board and by improving quality-control measures.

Roybal also said that, since these corrections, "the backlog of orders has been filled and production is up to par." Dealers and users we contacted are now pleased with the Apple III's performance.

The only negative remark concerns the lack of software for the Apple III. Word Painter, Apple's word processor for the Apple III, is not on the market, even though it was promised months ago; this fact has frustrated several Apple III purchasers. The delay, says Apple, is because Word Painter was written in Pascal, and the Apple III version of UCSD Pascal is only now being readied for release.

Apple III Software

Two new Apple III word processors, available from independent producers, should therefore be welcomed by users, dealers and Apple itself. Rainbow Computing, Inc., (19517 Business Center Drive, Northridge, CA 91324) has released Write-On III (for a review of the Apple II versions of Write-On, see the June 1981 *Byte*, p. 186). Also, Type-Righter has been announced by Imagineering, Inc. (c/o Adcast Advertising, 405 S. Farwell, Suite #10, Eau Claire, WI 54701). If these word processors are any indication, the Apple III software vacuum should soon be filled.

Some Apple III purchasers have also had trouble using its Apple II emulation mode. In this mode, the Apple III will run software written for the Apple II. Problems with this mode are, for the most part, I/O-related. For example, an Apple II program written for printer output with a printer interface card in slot 2 will not run on the Apple III. The reason is simple. The Apple III has a built-in printer interface that is addressable as slot 7. If the Apple II software is designed to look for the printer in slot 2, it won't work. But the solution is also simple. Modify the Apple II software to send printer output to slot 7. Most emulation mode problems can be similarly solved.

Apple knows it has made mistakes with the Apple III, but believes that they are now corrected. Apple's chairman and cofounder Steve Jobs expressed unqualified confidence while at Applefest '81 that the Apple III is finally on-line.

But beyond discussing software being developed for the Apple III, both Jobs and Roybal are close-mouthed about future Apple products. The message is that they won't disclose anything about new products until they're certain that those products are ready. ■

Apples Grow Well in Dallas

By Tom Lukers

Independent consultant Philip Russell is shown here training office staff on the fine points of VisiCalc on an Apple III.

Apple is getting good reviews from dealers in the Dallas area, where Apple recently opened a new manufacturing plant.

Retailers and consultants are reporting steady sales and satisfied customers, and are happy with Apple's factory support and promotional efforts.

"It wasn't long before we saw that almost all of our income was from Apple sales," says one dealer. Another adds that Apple constitutes about 80 percent of his sales.

Many customers are from large companies with corporate headquarters in Dallas. They like Apples because they work well either as stand-alone systems or as terminals in a corporate network. Some executives use them at the office, others use them at home and some do both.

The Apple's friendliness is the key to its success so far, dealers say.

"Most people want a buttoned-down system," says one retailer. "They want to be able to walk up to it and use it. Let's face it: most people aren't programmers or hardware hobbyists. They don't care about this bus, that bus or any bus. They just want to use the computer."

The same dealer says that the Osborne I, despite its price and features, won't have a great impact on Apple sales.

"The Osborne I isn't a friendly system," he says. "Besides, the guy who buys an Osborne I probably wouldn't have bought an Apple, anyway."

Pam Inserra, vice president of the KA Computer Store, says that several recent Apple promotional campaigns have given sales a shot in the arm.

For example, a recent Apple road show for dealers and the general public was extremely successful, she says, and was followed by an increase in sales. And the advertising campaign featuring Dick Cavett also helped the store.

"For a while, it was a regular occurrence for someone to walk through the door, saying, 'Dick Cavett sent me,'" she says.

People are not without their reservations. Independent consultant Philip Russell, for example, is critical of the lack of software support for the Apple III.

"As far as I'm concerned, the Apple II emulation mode is almost a failure, because of its inflexibility," he says. "I have even considered recommending to one of my clients that he go back to the Apple II because of this."

Compushop District Manager Richard Hartman warns that Apple could face some stiff competition if it isn't careful.

"Apple is by far our leading seller," he says. "But some really serious competition is looming on the horizon and Apple should be preparing for it. Atari sales are increasing every day. And Atari has the financial backing to give everyone a run for it." ■

Dr. Tom Lukers (PO Box 1949, 3625 Hendrick Drive, Plano, TX 75054, Micronet 70130,371) wrote the January 1981 cover story, "Assemble a Super Business System."

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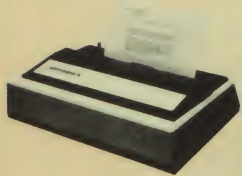

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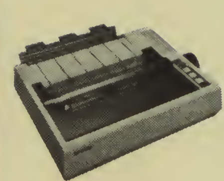

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You'd better not lie to your Apple when this program's running.

To Tell the Truth

By David B. Curtis

Can a computer replace Scotland Yard? How much stress do you feel when another Klingon enters your sector? Who ate the last piece of leftover mince pie? Who knows the answers to these questions?

The Apple II does, with the aid of this inexpensive and criminally simple way to connect it to a psychogalvanometer, or lie detector.

The skin surface of the human body carries small electrical currents, and has a measurable resistance. This resistance is lowered by tension, physical exertion and other factors, which may be the result of lying or another form of stress. Psychogalvanometers measure this varying resistance.

Radio Shack sells a lie detector unit *(catalog number 28-182)* for $11.95. It includes two sensors that attach to two fingers of the subject's hand. The relative skin resistance tunes the frequency of an audio oscillator, which drives a speaker. When the subject's resistance goes down, the pitch of the generated tone goes up proportionally.

Because of the audio output, the Radio Shack lie detector is simple to interface to the Apple II. You connect the output of the oscillator to the cassette input of the Apple II, and use a small machine-language program to measure the frequency of the audio output of the lie detector.

Construction

Assemble the Radio Shack lie detector kit according to the instructions that come with it. The kit is very simple; anyone who knows which end of a soldering iron to hold should have no trouble assembling it in less than an hour. Before proceeding to

Listing 1.

```
                 1000 *************************************
                 1010 *                                   *
                 1020 * LIE DETECTOR INTERFACE            *
                 1030 *                                   *
                 1040 * DATE THIS REVISION : 11-OCT-80    *
                 1050 *                                   *
                 1060 * ENTRY -                           *
                 1070 *   CALLED FROM APPLESOFT AS USR    *
                 1080 *   FUNCTION                        *
                 1090 *                                   *
                 1100 * INPUT - NONE                      *
                 1110 *                                   *
                 1120 * OUTPUT -                          *
                 1130 *   RETURN VALUE FROM 0-255         *
                 1140 *   REPRESENTING RELATIVE           *
                 1150 *   SKIN RESISTANCE                 *
                 1160 *                                   *
                 1170 *                                   *
                 1180 * TO USE -                          *
                 1190 *   APPLESOFT PROGRAM SHOULD        *
                 1200 *   BRUN LIE DETECTOR INTERFACE     *
                 1210 *   AS PART OF INITIALIZATION       *
                 1220 *                                   *
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                 1250 *                                   *
                 1260 *************************************
                 1270 *
                 1280 * INTERFACE EQUATES
                 1290 *
                 1300 USRVEC .EQ $A    ;START OF APPLESOFT USR VECTOR
                 1310 FLOAT  .EQ $E2F2 ;CHANGE INTEGER TO FLOATING POINT VALUE
                 1320 CASSIN .EQ $C060 ;CASSETTE INPUT ADDRESS
                 1330 *
                 1340 * SET START OF PROGRAM TO PAGE
                 1350 * $3 WHERE IT IS OUT OF THE WAY
                 1360 *
                 1370        .OR $315
                 1380 *
                 1390 * INITIAL ENTRY
                 1400 *   - SET UP USR VECTOR AND RETURN
                 1410 *
                 1420 JMPOP .EQ $4C    ;OP CODE FOR JMP
                 1430 INIT  .EQ *
0315- A9 4C      1440        LDA #JMPOP
0317- 85 0A      1450        STA USRVEC
0319- A9 25      1460        LDA #ENTRY
031B- 85 0B      1470        STA USRVEC+1
031D- A9 03      1480        LDA /ENTRY
031F- 85 0C      1490        STA USRVEC+2
0321- 60         1500        RTS
                 1510 *
                 1520 * STORAGE ALLOCATION
                 1530 *
0322- 00         1540 I        .DA #*-* ;INNER LOOP COUNTER
0323- 00         1550 J        .DA #*-* ;OUTER LOOP COUNTER
0324- 00         1560 PULSES .DA #*-* ;NUMBER OF PULSES SEEN
                 1570 *
                 1580 * TIMING EQUATES
                 1590 *   - LOOP FOR 16*255 TIMES
                 1600 *
                 1610 ISTART .EQ $FF
                 1620 JSTART .EQ $10
                 1630 *
```

More →

Address correspondence to David B. Curtis, Route 1, Cresco, IA 52136.

connect it to the Apple II, be sure that the lie detector operates properly in its unmodified form.

Modifying the lie detector for interfacing is simple. First, solder a miniature phono plug (the kind of plug that fits the cassette-in jack) to one end of a piece of two-conductor wire. Run the other end through a hole in the

Listing 1 continued.

```
                * LIE DETECTOR READ
                *    - ALL USER CALLS COME HERE
                *
                ENTRY  .EQ *
0325- A9 00            LDA #$0  ;CLEAR PULSE COUNTER
0327- 8D 24 03         STA PULSES
032A- A9 10            LDA #JSTART ;INITIALIZE OUTER
032C- 8D 23 03         STA J       ; LOOP COUNT
                CNTLO  .EQ *  ;OUTER LOOP ENTRY
032F- A9 FF            LDA #ISTART ;INITIALIZE INNER
0331- 8D 22 03         STA I       ; LOOP COUNT
                CNTLI  .EQ *  ;INNER LOOP ENTRY
0334- AD 60 C0         LDA CASSIN ;TEST CASSETTE INPUT
0337- 10 03            BPL NOPULS ;BRANCH IF NO PULSE
0339- EE 24 03         INC PULSES ;COUNT PULSE SEEN
                NOPULS .EQ *
033C- CE 22 03         DEC I
033F- D0 F3            BNE CNTLI ;LOOP (INNER) WHILE I NOT ZERO
0341- CE 23 03         DEC J
0344- D0 E9            BNE CNTLO ;LOOP (OUTER) WHILE J NOT ZERO
                *
                * CONVERT PULSES TO FLOATING
                * POINT VALUE LIKE APPLESOFT
                * EXPECTS AND RETURN
                *
0346- A9 00            LDA #$0
0348- AC 24 03         LDY PULSES
034B- 20 F2 E2         JSR FLOAT
034E- 60               RTS

SYMBOL TABLE

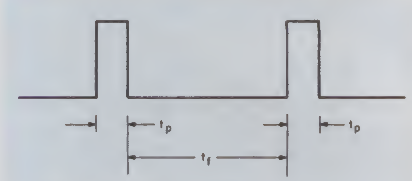
USRVEC 000A   FLOAT  E2F2   CASSIN C060
JMPOP  004C   INIT   0315   I      0322
J      0323   PULSES 0324   ISTART 00FF
JSTART 0010   ENTRY  0325   CNTLO  032F
CNTLI  0334   NOPULS 033C
```

```
>CALL-155

*315.34E

0315- A9 4C 85
0318- 0A A9 25 85 0B A9 03 85
0320- 0C 60 00 00 00 A9 00 8D
0328- 24 03 A9 10 8D 23 03 A9
0330- FF 8D 22 03 AD 60 C0 10
0338- 03 EE 24 03 CE 22 03 D0
0340- F3 CE 23 03 D0 E9 A9 00
0348- AC 24 03 20 F2 E2 60
*3D0G
```

Listing 2. A dump of the lie detector interface routine.



t_p = LENGTH OF PULSE (CONSTANT)

t_f = TIME BETWEEN PULSES (VARIED TO CHANGE PITCH)

Fig. 1. Lie detector audio output as seen by computer.

case of the lie detector, and solder one conductor to each side of the speaker.

Software Interface

The audio oscillator output (as seen by the computer) is a varying pulse signal like that shown in Fig. 1. The pulse is constant, and the pitch is varied by changing the time between pulses. The simplest method of finding the relative pitch is to count the number of pulses in a given period. This is what the machine-language program in Listing 1 does. The routine is designed to be used as a USR function from Applesoft in the same way that PDL is used to read the game paddles. When called from BASIC, the routine will return a number from 0 to 255. Refer to Listing 1 for details of the routine's design.

To install the program in your system, first get into the monitor by typing CALL −155. The Apple II should beep and display the * prompt. Listing 2 is a dump of the interface routine. Type each line as shown in the dump, changing all dashes (-) to colons (:). To re-create the dump and check for entry errors, type 315.34E. When the program is entered correctly, type 3D0G to return to BASIC. From BASIC, type BSAVE LIE DETECTOR DRIVER,A$315,L$40 to save the routine to disk.

Listing 3 shows a sample Applesoft program using the lie detector. A red lie-meter bar, which varies with skin resistance, is displayed using low resolution graphics.■

```
10  REM APPLESOFT PROGRAM TO DEMONSTRATE LIE DETECTOR INTERFACE
20  REM LAST REVISION 11-OCT-80
100  GOSUB 40000: REM INITIALIZE
110  REM SENSE-SCALE-DISPLAY LOOP
120 S =  USR (S): REM READ RELETIVE STRESS
130  REM S IS PASSED TO USR BUT IS NOT USED
140 S = S / 6: IF S > 38 THEN S = 38: REM SCALE S TO FIT LOW RES SCREEN
150  REM PAINT METER BAR
160  COLOR= RED: HLIN 0,S AT L
170  COLOR= BLACK: HLIN S + 1,39 AT L
180  GOTO 120: REM REPEAT FOREVER
40000  REM INITIALIZATIONS
40010 D$ =  CHR$ (4)
40020  REM LOAD THE INTERFACE ASSEMBLY CODE
40030  REM THE USR VECTOR IS SET UP AUTOMATICLY
40040  PRINT D$ + "BRUN LIE DETECTOR DRIVER"
40050 RED = 1: REM COLOR FOR METER BAR
40060 L = 20: REM LINE TO PLACE METER BAR
40070  GR : REM SET LOW-RES GRAPHIC MODE
40999  RETURN
```

Listing 3. A sample Applesoft program using the lie detector.

References

Apple II Reference Manual, Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014

Applesoft II Programming Reference Manual, Apple Computer, Inc.

S-C Assembler II Disk Version 3.2 Reference Manual, S-C Software, PO Box 5537, Richardson, TX 75080

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Down by the River

By Rolf A. Deininger, Richard L. Miller and Paul J. Capano

Photo 1. Martek water quality monitor and Apple microcomputer on a bridge over the Huron River in Ann Arbor, Michigan.

Automatic sensors used to monitor water quality will quickly gather much data. This gives you a great deal of flexibility: you can monitor a location over a period of time, a cross section of a river or different depths at a single location in a lake.

But large amounts of data can create significant handling problems. So instead of reading the data from the instruments, keypunching them and analyzing them later, we decided to use a microcomputer.

The advantage of this system is that data can be collected continuously and recorded in machine-readable form. No need to read the meters, write the values in notebooks and then keypunch them later for processing or storage. The data on the disk can be transferred to a larger computer system using the communications interface and a modem, and we do this routinely.

This small microcomputer system has extended our abilities to monitor water quality significantly and does it very cost-effectively.

The System

The computer is an Apple II, and the monitor is from Martek Instruments. Photo 1 shows the actual setup, on a bridge over the Huron River in Ann Arbor. The monitor and display are on the top shelf; the Apple, amplifier, disk drive and cables are on the middle shelf; and the power supply is on the bottom shelf.

Photo 2 shows the actual sensors which are lowered into the water. From left to right are the oxygen sen-

Address correspondence to Rolf A. Deininger, Professor of Environmental Health, The University of Michigan, Ann Arbor, MI 48109.

sor, the temperature sensor, the conductivity sensor and the pH sensor. The unit also has a depth sensor, which was not used.

The power source for the Apple and the display is a 12-volt recreational-vehicle battery connected to a 100-watt power inverter (Radio Shack Cat. No. 22-31) which produces 110 V ac. Our Apple draws about 0.3 amps at 110 V, and increases to about 0.4 amps during disk operations. The Sanyo display draws a little less than 0.3 amps at 110 V. Due to inefficiencies in the inverter, the battery drain is about 7 amps at 12 V. For a few hours of operation, the battery shown is sufficient; for longer times you'll need a larger battery. (Occasional use of the display also reduces power requirements.)

The Martek water quality monitor continuously monitors the temperature, the dissolved oxygen, the pH and the conductivity of the river water and displays the values on the panel meters. At a recorder output, all four signals are continuously available and range from 0 to 500 mV. These signals are then amplified by a factor of about eight using four LM308NA operational amplifiers.

An analog/digital (A/D) converter (AI-02 from Interactive Structures, Inc., Bala Cynwyd, PA) outputs digital voltage readings. The voltages sampled by the system were calibrated using known water samples and calibration signals available on the Martek monitor. We've written a simple program that will check the sensors for a predetermined number of samples at given time intervals (see Listing 1).

The program in Listing 2 produces a printout of data stored on disk. Data gathered one afternoon, stored on disk and later printed at our office using this program is shown in the Sample run.

Program Notes

The program in Listing 1 actually begins at line 1000, which sets the base addresses for the A/D converter (in slot 7 of our Apple). Lines 1010 through 1040 set the amplification and conversion factors for the four channels. Statement 1090, together with 160, produces the approximately desired sampling interval.

Since the Martek has several ranges for measurement of dissolved oxygen and conductivity, statements 1140 through 1190 are needed to set the desired range for each. Statement 1230 activates a scrolling window. The program goes to line 50. Lines 60 through 100 cause the A/D converter to initiate a conversion, read the converted values and round them to the first decimal place. Lines 110 through 150 print the data onto the monitor screen.■

Listing 1. Computer program in APPLESOFT for operating the system.

```
] LOAD WQ MONITOR
]LIST

10  REM  WATER QUALITY MONITORING SYSTEM
20  REM  WRITTEN BY R A DEININGER MAY 80
30  DIM SR( 600,4 )
40  GOTO 1000
50 SN = SN + 1
60  FOR I = 1 TO 4
70  POKE AP1,I
80 R =  PEEK (A) * 19.6 * CV( I ) / AF( I )
90 SR( SN,I ) =  INT ((R + .05 ) * 10 ) / 10
100  NEXT I
110  HTAB 3: PRINT SN;
120  HTAB 9: PRINT SR( SN,1 );
130  HTAB 16: PRINT SR( SN,2 );
140  HTAB 23: PRINT SR( SN,3 );
150  HTAB 29: PRINT SR( SN,4 )
160  FOR I = 1 TO DLAY: NEXT I
170  IF SN < NS THEN 50
180  IF SV$ = "N" GOTO 300
190 D$ =  CHR$ (4)
200  PRINT D$;"OPEN ";LOC$
210  PRINT D$;"WRITE ";LOC$
220  PRINT LOC$
230  PRINT NS
240  FOR I = 1 TO NS
250  PRINT SR( I,1 ): PRINT SR( I,2 )
260  PRINT SR( I,3 ): PRINT SR( I,4 )
270  NEXT I
280  PRINT D$;"CLOSE ";LOC$
300  HTAB 15: PRINT "...DONE..."
310  STOP
1000 A =  - 14592:AP1 = A + 1: REM  SLOT 7 ADDRESSES
1010 AF( 1 ) = 7.91:AF( 2 ) = 7.91
1020 AF( 3 ) = 7.91:AF( 4 ) = 8.0
1030 CV( 1 ) = .0234:CV( 2 ) = .0199
1040 CV( 3 ) = .0756:CV( 4 ) = .09
1050  PRINT "ENTER NAME OF SAMPLING STATION"
1060  INPUT LOC$
1070  PRINT "ENTER SAMPLING INTERVAL( SECS )"
1080  INPUT SECS
1090 DLAY = 700 * SECS
1100  PRINT "HOW MANY SAMPLES TO BE TAKEN"
1110  INPUT NS
1120  PRINT "SAVE THE DATA ON DISK( Y/N )"
1130  INPUT SV$
1140  PRINT "ENTER CONDUCTIVITY RANGE SELECTED"
1150  INPUT CR: IF CR > 100 OR CR < 2.5 THEN 1140
1160 CV( 4 ) = CV( 4 ) * CR / 50
1170  PRINT "ENTER DISS OXYGEN RANGE SELECTED"
1180  INPUT DR: IF DR > 20 OR DR < 2 THEN 1170
1190 CV( 2 ) = CV( 2 ) * DR / 10
1200 SN = 0: CALL  - 936
1210  PRINT "LOCATION: ";LOC$: PRINT : PRINT
1220  PRINT "SAMPLE#   PH   DIS OX   TEMP    COND"
1230  POKE 34,4
1240  GOTO 50
1250  END
```

Listing 2. Program that produced the Sample run.

```
10  REM  MARTEK DATA READER
11  DIM SR( 600,4 )
20 D$ =  CHR$ (4)
30  PRINT "ENTER NAME OF FILE"
40  INPUT FI$
```

More

Listing 2 continued.

```
50   PRINT D$;"OPEN ";FI$
60   PRINT D$;"READ ";FI$
70   INPUT LOC$
80   INPUT NS
90   FOR I = 1 TO NS
100   INPUT SR(I,1): INPUT SR(I,2)
110   INPUT SR(I,3): INPUT SR(I,4)
120   NEXT I
130   PRINT "LOCATION: ";LOC$
140   PRINT : PRINT
150   PRINT "SAMPLE#  PH  DIS OX   TEMP  COND"
160   FOR I = 1 TO NS
170   HTAB 3: PRINT I;
180   HTAB 9: PRINT SR(I,1);
190   HTAB 16: PRINT SR(I,2);
200   HTAB 23: PRINT SR(I,3);
210   HTAB 29: PRINT SR(I,4)
220   NEXT I
230   HTAB 15: PRINT "...DONE..."
240   END
```

```
]RUN
ENTER NAME OF FILE
?HURON RIVER BRIDGE (6/24/80-1PM)
LOCATION: HURON RIVER BRIDGE (6/24/80-1PM)


    SAMPLE#   PH   DIS OX   TEMP   COND
      1       8.3    8.1    21.8   56.2
      2       8.3    8.1    21.8   56.2
      3       8.3    8.1    21.8   56.2
      4       8.3    8.1    21.8   56.2
      5       8.3    8.1    21.8   56.2
      6       8.3    8.1    21.8   56.2
      7       8.3    8.1    21.8   56.2
      8       8.3    8.1    21.8   56.2
      9       8.3    8.1    21.8   56.2
      10      8.3    8.1    21.8   56.2
                  ...DONE...
```

Sample run.

Photo 2. Sensor assembly for dissolved oxygen, temperature, pH value and conductivity.

Apple to Selectric for 83 Cents

By Charles Behrens

For 83 cents and some intriguing tinkering, your Apple can control any peripheral device with a serial input port. Of course, there are many interface cards on the market designed to do just this, but they usually cost several hundred dollars. Who needs that when every Apple already has what it takes!

PET, Atari, Ohio Scientific and other microcomputer owners should also take note: the technique can be applied to virtually any system. The program listings supplied here are written in 6502 assembly language and can be readily adapted.

To test my new hardware addition, I wrote a short software routine to control an IBM Selectric typewriter/printer. It works beautifully.

The Apple II was designed for easy interface to the outside world. All of the proper signals for controlling peripherals were brought out to the Apple II's ports, and they are just aching to be harnessed. Here's how to take maximum advantage of what the folks at Apple have already provided.

Interface Construction

To create the interface, you must do four things:

- Write a software routine to translate the Apple's internal American Standard Code for Information Interchange (ASCII) coded data from a parallel format to the proper serially-coded format that the Selectric can use.
- Output this serial data to a latched port on the game paddle I/O connector.
- Build a simple, one-transistor circuit to supply the needed transistor-transistor-logic (TTL) to RS-232C voltage conversions. (See reference 1 for background on steps 1 and 3.)
- Add +12 and −12 V supply voltages to the two unused pins on the game paddle connector.

The best reward is that the only costs are for a little one-transistor circuit. Not only that, but the little circuit fits inside a case like the one on the plug of the game paddle controllers. How convenient can you get!

Photo 1. *The author's system with Carterfone S15B Selectric I at left. Notice the "customized" paper dispenser from the local hardware store. (All photos by Michael La Pointe.)*

Inside the Selectric

To understand the software, you must first understand the coding format that IBM designed into its printers.

The IBM Selectrics use a six-bit code. You might ask how this can be. Given that there are 128 unique characters in the seven-bit ASCII code, how can just six bits generate enough different symbols to represent all of the letters needed? It's an old trick that the inventors of the modern typewriter developed. They were faced with the dilemma: With the great number of characters used in

Address correspondence to Charles Behrens, PO Box 233, Kingston, RI 02881.

CHARACTER	ASCII	CORR	BCD	EBCD
NUL	80	7F	7F	7F
SOH	81	7F	7F	7F
STX	82	7F	7F	7F
ETX	83	7F	7F	7F
EOT	84	FC	FC	FC
ENQ	85	7F	7F	7F
ACK	86	7F	7F	7F
BELL	87	7F	7F	7F
BACK SPACE	88	5D	5D	5D
TAB	89	2F	2F	2F
LINE FEED	8A	6E	6E	6E
VERT. TAB	8B	7F	7F	7F
FF	8C	7F	7F	7F
CAR. RET.	8D	6D	6D	6D
SO	8E	7F	7F	7F
SI	8F	7F	7F	7F
DLE	90	7F	7F	7F
DC1	91	7F	7F	7F
DC2	92	7F	7F	7F
DC3	93	7F	7F	7F
DC4	94	7F	7F	7F
NAK	95	7F	7F	7F
SYN	96	7F	7F	7F
ETB	97	7F	7F	7F
CAN	98	7F	7F	7F
EM	99	7F	7F	7F
SUB	9A	7F	7F	7F
ESC	9B	7F	7F	7F
FS	9C	7F	7F	7F
GS	9D	7F	7F	7F
RS	9E	7F	7F	7F
US	9F	7F	7F	7F
SPACE	A0	40	40	40
!	A1	81	75	75
"	A2	49	38	34
#	A3	70	B4	B4
$	A4	04	F5	F5
%	A5	08	68	68
&	A6	68	C3	C3
'	A7	C9	58	58
(	A8	34	64	64
)	A9	64	54	54
*	AA	38	04	04
+	AB	13	34	43
'	AC	3B	F6	F6
–	AD	B7	81	81
.	AE	51	B7	B7
/	AF	87	E2	E2
0	B0	E4	D4	D4
1	B1	C6	A0	A0
2	B2	90	90	90
3	B3	F0	F0	F0
4	B4	84	88	88
5	B5	88	E8	E8
6	B6	D8	D8	D8
7	B7	E8	B8	B8
8	B8	B8	84	84
9	B9	B4	E4	E4
:	BA	6B	08	08
;	BB	EB	70	70
<	BC	7F	7F	10
=	BD	93	20	20
>	BE	7F	7F	38
?	BF	07	62	62
@	C0	70	82	82
A	C1	79	23	23
B	C2	76	13	13
C	C3	7A	73	73
D	C4	2A	0B	0B
E	C5	4A	6B	6B
F	C6	73	5B	5B
G	C7	23	3B	3B
H	C8	26	07	07
I	C9	19	67	67
J	CA	43	61	61
K	CB	1A	51	51
L	CC	46	31	31
M	CD	61	49	49
N	CE	52	29	29
O	CF	45	19	19
P	D0	0B	79	79
Q	D1	5B	45	45
R	D2	29	25	25
S	D3	25	52	52
T	D4	02	32	32
U	D5	32	4A	4A
V	D6	31	2A	2A
W	D7	75	1A	1A
X	D8	62	7A	7A
Y	D9	67	46	46
Z	DA	54	26	26
L. BRACK.	DB	7F	7F	7F
B. SLASH	DC	7F	7F	7F
R. BRACK.	DD	7F	7F	7F
CIRCUMFLEX	DE	7F	7F	7F
—	DF	7F	01	01
SPACE	E0	40	40	40
a	E1	F9	A3	A3
b	E2	F6	93	93
c	E3	FA	F3	F3
d	E4	AA	8B	8B
e	E5	CA	EB	EB
f	E6	F3	DB	DB
g	E7	A3	BB	BB
h	E8	A6	87	87
i	E9	99	E7	E7
j	EA	C3	E1	E1
k	EB	9A	D1	D1
l	EC	C6	B1	B1
m	ED	E1	C9	C9
n	EE	D2	A9	A9
o	EF	C5	99	99
p	F0	8B	F9	F9
q	F1	DB	C5	C5
r	F2	A9	A5	A5
s	F3	A5	D2	D2
t	F4	82	B2	B2
u	F5	B2	CA	CA
v	F6	B1	AA	AA
w	F7	F5	9A	9A
x	F8	E2	FA	FA
y	F9	E7	C6	C6
z	FA	D4	A6	A6
L. BRACE	FB	7F	7F	7F
		FC	7F	7F	7F
R. BRACE	FD	7F	7F	7F
WAVE	FE	7F	7F	7F
RUB	FF	7F	7F	7F

Table 1. ASCII-to-Selectric conversion table. Any Selectric can support all three codes, depending on which type element is installed by the user (reference 1).

```
9580- 7F 7F 7F 7F 8B 7F 7F 7F
9588- 5D 2F 6E 7F 7F 6D 3E 7F
9590- 7F 7F 7F 7F 7F 7F 7F 7F
9598- 7F 7F 7F 7F 7F 7F 7F 7F
95A0- 40 75 34 B4 F5 68 C3 58
95A8- 64 54 04 43 F6 81 B7 E2
95B0- D4 A0 90 F0 88 E8 D8 B8
95B8- 84 E4 08 70 10 20 38 62
95C0- 82 23 13 73 0B 6B 5B 3B
95C8- 07 67 61 51 31 49 29 19
95D0- 79 45 25 52 32 4A 2A 1A
95D8- 7A 46 26 7F 7F 37 76 7F
95E0- 40 A3 93 F3 8B EB DB BB
95E8- 87 E7 E1 D1 B1 C9 A9 99
95F0- F9 C5 A5 D2 B2 CA AA 9A
95F8- FA C6 A6 7F 7F 01 52 20
```

Table 2. This is the cross-reference table I am currently using with my Selectric typewriter/printer. I have adapted some of the characters for special uses, so this table does not exactly correspond with Table 1.

written print, how does one make an efficient keyboard for ten-fingered humans? As a solution, the shift key was invented. Suddenly only half as many separate keys were needed to create the entire character set. When the Teletype came along, the designers realized that the same trick could be used to speed up transmitted electronic information.

Naturally, when IBM Selectrics were outfitted as data terminals, the old dog used the same old trick. And it is this same trick that our program uses to generate any character desired. When the Selectric is to be sent an uppercase letter, a shift-up must precede it. Any letter sent from then on will be in uppercase until a shift-down code is transmitted. The software technique for doing this will be described shortly.

Next, you need to understand that IBM Selectrics use three different six-bit codes. The reason for this is that there are three different methods of configuring the letters on the type element. The style of type element installed in the machine determines which code is to be used. If the wrong code is transmitted to the Selectric, it will print nonsense. The codes used are extended binary-coded decimal (EBCD), binary-coded decimal (BCD) and correspondence code. (See Table 1.)

EBCD and BCD printheads are fine for utility printing, but if you need to do a great deal of word processing, then get a correspondence-code element. It offers a greater variety of character fonts (e.g., script, oversize, special characters, etc.). Conveniently, every style may be used on the same machine. It is not necessary to own separate typewriters; just different type elements.

By relying on a software method of controlling the Selectric, three different look-up tables can be created to handle each style of code. This would be expensive to do with a hardware approach. But with software, you can load any of the codes separately. This offers the versatility of having all three while only tying up a minimal amount of memory space for one at a time.

Now that these points are understood, let's move into the workings of the software.

The Program

The 6502 assembly-language routine (see Listing 1) is used for translating the Apple's internal character data to the needed serial code (references 2 and 3). The program is short enough to fit in even a 16K Apple. This program will be called in every mode of the Apple's operation. Anything that can be displayed on the video screen can be printed. In other words, it may be used for word processing, BASIC program listings, monitor listings and even to obtain hard copies of program output.

The first duty of the program is to intercept the desired ASCII character before it is sent to the usual output routine in the Apple II's Monitor. Normally, this is the COUT1 routine at $FDF0 (the "$" sign indicates a hexadecimal number), used for displaying output on the video screen. When a character is to be output, the routine at $FDFE named COUT reads the values at $36 and $37 to determine the address of the output routine. Because the output routine is indirectly called, it is easy to divert the program flow by substituting a new address. This is a technique called vectoring.

The routine listed here loads its own beginning address to locations $36 and $37, instead of the address for COUT1. In this way, COUT will vector to the printing routine when it tries to output a character. For convenience, the print routine branches to COUT1 after printing so that the character is also displayed on the video screen.

Once the printing routine has been called, its first step is to save all of the working registers in memory. This is so that everything will be intact when the routine returns from the call.

At the beginning of the routine, the accumulator contains the desired ASCII character. The code for this character is also stored separately in location $FC of page zero for easy recall. Execution then proceeds into the

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heart of the program.

A check is made to determine if a carriage return is to be output. If so, then three things must happen. First, the Carriage Return must be preceded with a Shift-Up command. Second, a carriage return character must be sent. Third, an extra long delay is needed to give time for the carriage to physically move back to the start of the next line before trying to print the next character.

The extra shift-up is needed to work properly with the word processor program, Apple Writer. Otherwise, the Selectric sometimes will not properly decode the carriage return character. Obviously word processing with Apple Writer is not the only use for the printer. During those other times, it is necessary to replace the extra shift-up character to a null character to prevent errors. Change the $9C in location $9DF7 of the program to a $FF and you'll be all set.

The indexed addressing mode of the 6502 is invaluable for determining the properly cross-referenced Selectric code. Knowing that the ASCII characters are represented by the values $80 through $FF, the ASCII-to-Selectric cross-referencing table is loaded into locations $80 through $FF of a page in memory immediately following the program. (See Table 2.) The page number containing the look-up table is then set as the base address of the indexed addressing instruction.

The value of the needed ASCII character is then loaded into the Y register. By adding the value of the Y register to the base address, the right code in the look-up table can be found with just one instruction! This value is then tucked away for safekeeping in location $FB of page zero.

Once the Selectric character code is obtained, the next step is to figure out whether it is an upper or lowercase letter. Not only that, but also whether or not the last letter sent was of the same case. This is done by comparing the most-significant bit (MSB) of the character code with the MSB in location $FA. The MSB denotes the case of the letter, and location $FA holds the case of the last letter sent.

If the new character is not of the

Listing 1. This 6502 assembly-language routine is the foundation of the Apple/Selectric interface described in this article. The same logic will also work with Atari, PET, Ohio Scientific and other 6502-based micros with only minor changes. Due to vectoring, it can be located in any convenient section of memory. Note: change location $94F7 to $FF when not using the Apple Writer word processor. (See text.)

```
                                         **PRINTER OUTPUT ROUTINE
94D4-    A9 E0        LDA    #$E0         LOAD $94E0 AS VECTOR BRANCH FOR 'COUT'
94D6-    85 36        STA    $36          LOW BYTE IN $36
94D8-    A9 94        LDA    #$94
94DA-    85 37        STA    $37          HIGH BYTE IN #37
94DC-    20 51 A8     JSR    $A851        SET D.O.S. VECTORS
94DF-    60           RTS

                                         **SAVE-SAVE ALL REGISTERS
94E0-    48           PHA
94E1-    08           PHP
94E2-    86 FE        STX    $FE
94E4-    84 FF        STY    $FF
94E6-    20 F0 94     JSR    $94F0        JUMP TO **BEGIN

                                         **RESTORE-RESTORE ALL REGISTERS
94E9-    A6 FE        LDX    $FE
94EB-    A4 FF        LDY    $FF
94ED-    28           PLP
94EE-    68           PLA
94EF-    60           RTS                 RETURN TO CALLING PROGRAM

                                         **BEGIN-THE MAIN PROGRAM
94F0-    85 FC        STA    $FC          STORE THE ASCII CHARACTER IN $FC
94F2-    C9 8D        CMP    #$8D         CHECK TO SEE IF IT IS A CARRIAGE RETURN
94F4-    D0 0C        BNE    $9502        IF NOT, BRANCH TO **LOOKUP
94F6-    A9 9C        LDA    #$9C         ELSE, OUTPUT A 'SHIFT UP'
94F8-    20 27 95     JSR    $9527        JUMP TO **SERIAL
94FB-    A9 ED        LDA    #$ED         THEN A CARRIAGE RETURN
94FD-    20 27 95     JSR    $9527        JUMP TO **SERIAL
9500-    F0 4B        BEQ    $954D        BRANCH TO LONG DELAY

                                         **LOOKUP-CROSS REFERENCE ASCII TO SELECTRIC
9502-    A8           TAY                 USE Y-REGISTER AS OFFSET WITHIN TABLE
9503-    B9 00 95     LDA    $9500,Y      LOAD FROM TABLE
9506-    85 FB        STA    $FB          STORE FOR SAFE KEEPING

                                         **CASE-CHECK CURRENT CASE AGAINST LAST
9508-    29 80        AND    #$80         MASK OFF BITS 0-6
950A-    C5 FA        CMP    $FA          CHECK M.S.B. AGAINST LAST CHARACTER SENT
950C-    85 FA        STA    $FA          SAVE NEW M.S.B.
950E-    F0 0E        BEQ    $951E        IF SAME CASE, BRANCH TO **PREP
9510-    90 07        BCC    $9519        NEED A 'SHIFT UP'?

                                         **SHIFT DOWN-SEND A SHIFT DOWN
```

More

Listing 1 continued.

```
9512-   A9 9F      LDA   #$9F     LOAD SHIFT DOWN CODE
9514-   20 27 95   JSR   $9527    JUMP TO **SERIAL
9517-   F0 05      BEQ   $951E    BRANCH TO **PREP

                             **SHIFT UP-SEND A SHIFT UP
9519-   A9 9C      LDA   #$9C     LOOAD SHIFT UP CODE
951B-   20 27 95   JSR   $9527    JUMP TO **SERIAL
                             **PREP-PREPARE CHARACTER FOR SERIAL OUTPUT
951E-   A5 FB      LDA   $FB      RELOAD CHARACTER CODE
9520-   09 80      ORA   #$80     SET M.S.B. FOR USE AS 'STOP BIT'
9522-   20 27 95   JSR   $9527    JUMP TO **SERIAL
9525-   F0 31      BEQ   $9558    BRANCH TO **VIDEO

                             **SERIAL-SERIALIZE AND OUTPUT CHARACTERS
9527-   A2 09      LDX   #$09     SET COUNTER
9529-   86 FD      STX   $FD      STORE COUNTER IN $FD
952B-   18         CLC            CLEAR CARRY BIT TO USE AS 'START BIT'

                             **OUTPUT-OUTPUT BITS
952C-   90 08      BCC   $9536    BRANCH TO **ZERO IF CARRY CLEAR

                             **ONE-OUTPUT A LEVEL ONE
952E-   8D 59 C0   STA   $C059    TURN ON 'AN#0' PORT
9531-   20 42 95   JSR   $9542    JUMP TO **DELAY
9534-   F0 06      BEQ   $953C    BRANCH TO **ROLL

                             **ZERO-OUTPUT A LEVEL ZERO
9536-   8D 58 C0   STA   $C058    TURN OFF 'AN#0' PORT
9539-   20 42 95   JSR   $9542    JUMP TO *DELAY

                             **ROLL-INCREMENT TO NEXT BIT
953C-   6A         ROR            ROLL NEXT BIT INTO THE CARRY BIT
953D-   C6 FD      DEC   $FD      DECREMENT THE COUNTER
953F-   D0 EB      BNE   $952C    LOOP BACK TO **OUTPUT
9541-   60         RTS            RETURN

                             **DELAY-DELAY FOR 7.43MS
9542-   A2 CE      LDX   #$CE     SET COUNTER OF OUTER LOOP

                             **OUTER
9544-   A0 06      LDY   #$06     SET COUNTER OF INNER LOOP

                             **INNER
9546-   88         DEY            DECREMENT INNER LOOP
9547-   D0 FD      BNE   $9546    LOOP BACK TO **INNER
9549-   CA         DEX            DECREMENT OUTER LOOP
```

More

same case as the last one sent, then a shift-up or shift-down character must be transmitted. When the most-significant bits are different, the carry bit of the 6502's processor register indicates in which direction the shift should occur.

After servicing the shift subroutine, execution moves into the output subroutine. The purpose of this section of the program is to change the data from a parallel to serial format. For this a latched output port is needed. There are four of these on the Apple II, but only one is required. By alternately setting and clearing annunciator output 0 on the game paddle connector, a serial bit stream can be generated. The timing of each bit must be 7.43 milliseconds (ms) long, easily done with delay loops. Also, each character must be preceded with a start bit of logic 0 and followed with a stop bit of logic 1.

The first step of the output subroutine is to mask the no longer needed MSB to a logic 1 for later use as the stop bit. Next, the program clears the carry bit of the 6502. This provides the needed start bit. The 0, now in the carry bit, is transferred to annuncia-

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Listing 1 continued.

```
954A-   D0 F8       BNE   $9544    LOOP BACK TO **OUTER
954C-   60          RTS            RETURN

                                 **LONG DELAY-FOR CARRIAGE RETURN
954D-   A9 85       LDA   #$85     SET COUNTER
954F-   85 FB       STA   $FB      STORE COUNTER IN $FB

                                 **MACRO
9551-   20 42 95    JSR   $9542    JUMP TO **DELAY
9554-   C6 FB       DEC   $FB      DECREMENT COUNTER
9556-   D0 F9       BNE   $9551    LOOP BACK TO **MACRO
                                 **VIDEO
9558-   A5 FC       LDA   $FC      RELOAD ORIGINAL ASCII CODE
955A-   48          PHA            SAVE IT ON THE STACK
955B-   29 F0       AND   #$F0     MASK OFF BITS 0-3

                                 **UPPERCASE-ASCII CHARS. $C0-$DF
955D-   C9 C0       CMP   #$C0     IS IT CAPITOL A-O, ETC.?
955F-   F0 04       BEQ   $9565    BRANCH TO **INVERSE
9561-   C9 D0       CMP   #$D0     IS IT CAPITOL P-Z, ETC.?
9563-   D0 07       BNE   $956C    BRANCH TO **LOWERCASE

                                 **INVERSE-OUTPUT AN INVERSE CHARACTER
9565-   68          PLA            GET CHARACTER FROM STACK
9566-   29 3F       AND   #$3F     MASK OFF BITS 6 & 7
9568-   20 F0 FD    JSR   $FDF0    JUMP TO 'COUT1'
956B-   60          RTS            RETURN TO **RESTORE

                                 **LOWERCASE-ASCII CHARS. $E0-$FF
956C-   C9 E0       CMP   #$E0     IS IT SMALL A-O, ETC.?
956E-   F0 04       BEQ   $9574    BRANCH TO **NORMAL
9570-   C9 F0       CMP   #$F0     IS IT SMALL P-Z, ETC.?
9572-   D0 07       BNE   $957B    BRANCH TO **SAME

                                 **NORMAL-OUTPUT A NORMAL CHARACTER
9574-   68          PLA            GET CHARACTER FROM STACK
9575-   29 DF       AND   #$DF     MASK OUT BIT 5
9577-   20 F0 FD    JSR   $FDF0    JUMP TO 'COUT1'
957A-   60          RTS            RETURN TO **RESTORE

                                 **SAME-OUTPUT CHARACTER AS IS
957B-   68          PLA            GET CHARACTER FROM STACK
957C-   20 F0 FD    JSR   $FDF0    JUMP TO 'COUT1'
957F-   60          RTS            RETURN TO **RESTORE
```

tor 0 in the first cycle of the output subroutine loop, and is followed by a call to the 7.43 ms delay loop.

Next, the accumulator is right-shifted to place the first bit of the character code into the carry bit. The annunciator 0 output is then set or cleared to reflect the value of the carry bit. Again, the level is held for 7.43 ms. This cycle continues until all six bits of the character code, a seventh bit for parity checking, and the logic 1 MSB as a stop bit are transferred serially to the annunciator 0 port.

The exact timing of each delay is easily adjusted by changing the limits of the delay loops. Since the Apple II executes about one machine cycle per microsecond, the limits were determined by counting the number of machine cycles per loop and dividing this number into 7.43 ms. Bear in mind that if this were being timed by hardware, delicate timing circuits would have to be used. Again, because software can be easily changed, it can be much less trouble.

Only one more task is left for the annunciator port to have all of the proper data. That is to provide for an

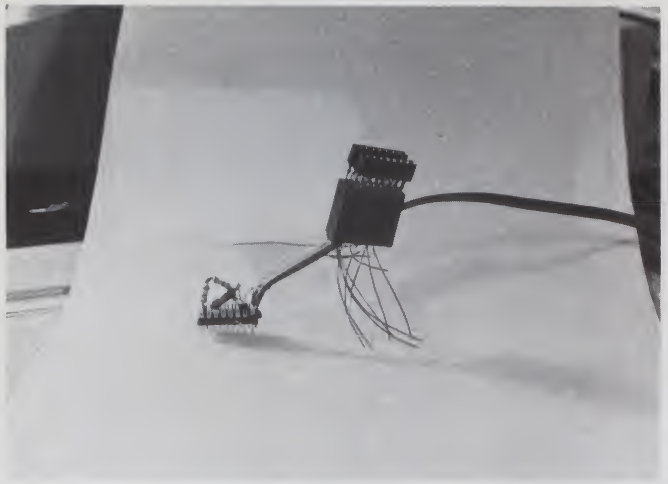

Photo 2. *The 83-cent circuit before final assembly. The DIP socket was wire-wrapped to the pins below and the case glued shut.*

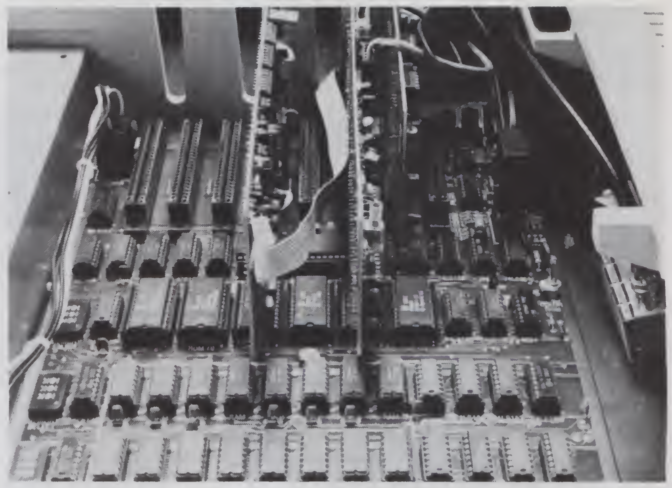

Photo 3. *Main circuit board with peripherals connected. Plug game paddles and the new RS-232C output into game paddle socket (upper right).*

extra long delay if a carriage return character is sent. Another delay loop is used to call the 7.43 ms loop several times to provide a sufficient pause.

At this point in the processing, the routine could return directly to COUT1. However, with a little more attention to details, I added a subroutine to return inverse video characters if uppercase letters were printed. This is done by masking the normal video mode ASCII codes. With lowercase letters bits 4–7 were masked to allow them to be displayed in normal video. The other characters are output without change. As this is the same technique many word processor programs employ, it is especially convenient for proofreading during printout.

The program in Listing 1 locates the routine at a convenient place in memory of a 48K disk system. By setting the HIMEM limit to just below its starting address, it is protected from most BASIC applications.

However, there may be some systems in which it would be better to locate it at a different address. It is relatively straightforward to relocate the program wherever you want by attending to the jump-to-subroutine

RS-232 Standard Pin Designation

1. Ground
2. Data (Transmit)
3. Data (Receive)
4. Request to Send
5. Clear to Send
6. Data Set Ready
7. Ground
8. Carrier Detector
9. Data Set Test
10. Data Set Test
11. Unassigned
12. Secondary Carrier Detector
13. Secondary Clear to Send
14. Secondary Data (Transmit)
15. Xmit. Clock (DCE)
16. Secondary Data (Receive)
17. Rcvr. clock (DCE)
18. Unassigned
19. Secondary Request to Send
20. Data Terminal Ready
21. Signal Quality Detector
22. Ring Indicator
23. Data Signal Rate Selector
24. Xmit Clock (DTE)
25. Unassigned

Table 3. DB-25 plug. Only pins 3, 5 and 7 are used here. Perhaps you can figure out a way to use the transmit signals so that the terminal can transmit as well as receive.

(JSR) instructions.

RS-232C Signals from Apple II

RS-232C signal standards were designed to supply large enough voltage swings that they would not be overcome by transmission noise on the wire between the sender and the receiver. For this reason, voltage levels were designed to be from +5 to +15 V for logic level 1 and −5 to −15 V for logic level 0. The only thing that the Selectric needs at its input port is an RS-232C serial data line and a ground reference. What this implies is that a simple single-pair speaker wire will carry all of the information needed. It may be run fairly long distances and there is no need for expensive ribbon cable.

The annunciator 0 port of the game paddle I/O connector can only provide a TTL level voltage swing of 0–5 V. Fortunately, it is a simple task to amplify these levels to RS-232C compatible voltages with a one-transistor circuit (see Fig. 1). The entire circuit consists of only five small parts, so with very little effort it can be built on top of a 16-pin dual-inline plug (DIP). A small cap can then be glued over the circuit, leaving only the speaker wire running out of it. Any time there is a need to disconnect the printer, just pull the plug.

Additionally, it is not too difficult to connect another DIP socket onto the top of the transistor circuit cap. This can carry signals connected in parallel to the game paddle connector beneath it. That way the game paddles may remain plugged in while the printer is being used, eliminating wear and tear on the plugs.

The parts for this circuit are cheap and easy to find. By using a few junk box components and a couple of Radio Shack parts, my total costs were (yes) exactly 83 cents! I highly recommend building a test circuit on an experimenter's protoboard to check the circuit performance before soldering it into its case. That will help prevent

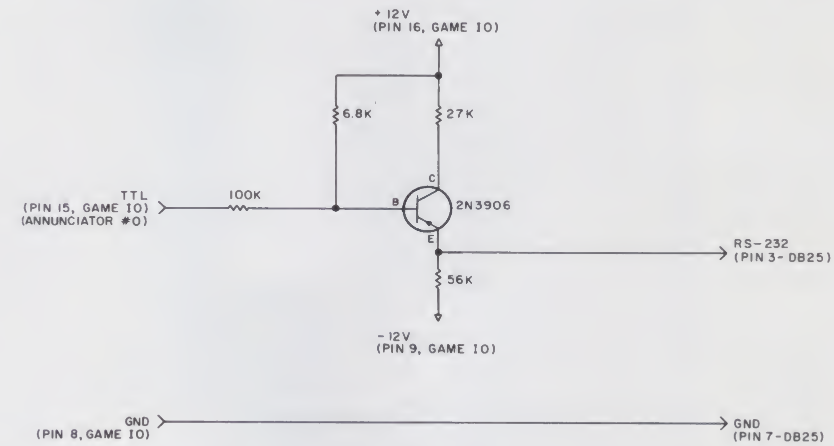

Fig. 1. TTL-to-RS-232 driver circuit. This one-transistor circuit is the major cost factor in this project! Harness it properly and it can also be used to drive modems, high speed printers, synthesizers or any other serial input device.

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wasted time if there is a need to debug the circuit.

The final part of creating an RS-232C port is the easiest to understand, but it goes against the grain of every Apple II owner I know. Don't worry! It's really quite minor, but it does mean modifying the Apple's main board. This is your chance to enhance the original design. It is nothing that is not already right there on the board; it's just not in enough places. This modification will improve your Apple II just by adding two small jumpers. The main consideration before taking this step should be the loss of the warranty. If the warranty loss is outweighed by your improvement, then plunge onward.

The final step is to run two wires to the two unused pins of the game paddle connector. These provide the +12 and −12 V supplies to the transistor circuit for the RS-232C voltage references. Check the Apple II Reference Manual (a great piece of work!) and observe that slot 7 has both of the needed voltages readily available and right next to the paddle connector.

The first wire should be run from pin 33 of slot 7 to pin 9 of the paddle connector. The other wire is run from pin 50 of slot 7 to pin 16 of the game paddle connector. To attach the wires, you must get at the back of the main circuit board.

First, turn the Apple II off and remove all cables (line cord, video, cassette, etc.). Then lift off the lid from the Apple II by pulling up sharply at the rear of the lid to unsnap the Hedlok fasteners. Set the lid aside.

Disconnect all plug-in cards (disk drive, modem, etc.) and any remaining video or game connector cables.

Next, clear a large, clean work surface and protect it with a pad of some sort (e.g., a scrap of rug). Place the Apple II upside down upon it.

Unscrew the four black screws just under the front edge of the keyboard (see Fig. 2) and carefully set them aside. Next, unscrew the two screws on the outer edge of the left side, and the same on the right side. Unscrew the two last screws on each side of the back edge. Do not lose these screws!

Now, while tightly holding the top and bottom sections together, turn the Apple II right-side up. Slowly lift up the front edge of the top section about two inches. Unplug the keyboard connector from the main board. Lay the top section aside.

Unplug the power supply by unclipping the metal fasteners. Unplug the speaker.

The main circuit board is attached to the bottom section by six nylon board supports and one 6/32 nut. First unscrew the nut from the center of the board. Then, starting at one end and working across, unclip the

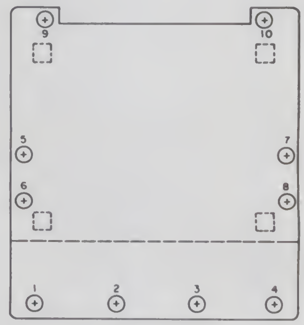

Fig. 2. Remove only the screws indicated here. Be careful not to separate the top and bottom until the keyboard connector is unplugged.

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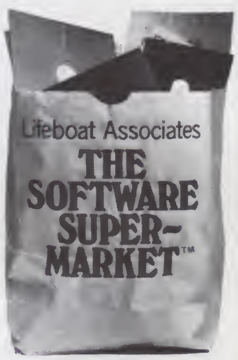

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Software with full support

nylon supports by lightly pinching them with a small pair of pliers. Be sure not to miss the one at location J9. The main circuit board should now be separated. Remove the main circuit board from the base and set the base aside.

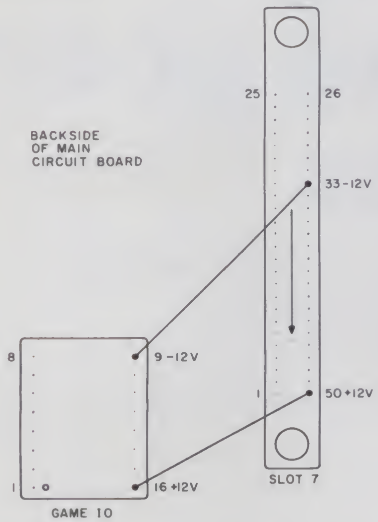

Fig. 3. Add these two jumpers to the back of your Apple's main circuit board to boost its capabilities. The most common mistake is to miscount the pins.

Referring to Fig. 3, connect the new wire jumpers to their respective pins on the rear of the circuit board. Use small #22–#28 gauge solid wire. Do not use stranded wire; it tends to fray, possibly shorting to other nearby pins.

Measure the distance between the pins with a length of wire and cut it 1/4-inch longer than measured. Strip off 1/8-inch of insulation from each end. Make a small loop in the stripped end of the wire and hook it to the pin. Lightly touch a soldering pencil to the connection and feed in a minimal amount of solder. Avoid using too much solder; it could flow across to the next pin, causing a short.

The main problem to watch for at this stage is miscounting the pins on their respective sockets. Use insulated wire and clean soldering techniques, and you should not have a problem. Reassemble everything in reverse order. When the power is reapplied, check the modification with a voltmeter before plugging in the transistor circuit. Reversing the supplies on the transistor could damage your unit.

Once the modification is completed and checked, plug in the transistor circuit and measure the output voltage level. By slowly toggling the annunciator 0 port with the BASIC program in Listing 2, voltage swings in the 5–15 V range on either side of ground should be observed. If not, check the wiring and the values of the resistors. Also, the parameters of different transistors may vary, so try substituting a few to obtain the most balanced voltage swings.

The Printer Connection

Now that everything is done at the output end, it is time to prepare the Selectric for data input. On the back of the Selectric are two points of interest. The first is the DB-25 plug; the other is the line/local switch. Table 3 shows the pinout designations for the DB-25 plug. The idea is to trigger the terminal into the receive mode without having to supply another wire from the computer.

Because of this, only three pins on the DB-25 plug have significance in this application. Pin 3 receives the RS-232C serial data stream from the

driver program. Pin 7 is the ground reference from the Apple II. And pin 5 needs to be supplied a logic 1 voltage level to set the terminal in the receive mode.

The logic 1 voltage for pin 5 is supplied from the 5 V supply within the printer. Unsnap the rear cover from the printer and locate the terminal block on the circuit board within. The terminal with the green wire is the 5 V supply. The one with the black wire is the ground. Measure their levels to confirm this. Connect a short wire from the 5 V terminal to pin 5 of the DB-25 plug. That is the only work needed on the printer.

```
1  REM
        TOGGLE ANNUNCIATOR #0

10  POKE  - 16296,0: REM - OFF
20  GET A$: REM - PAUSE
30  POKE  - 16295,0: REM - ON
40  GET A$: REM - PAUSE
50  GOTO 10
```

Listing 2. The SWITCH program is for switching annunciator port 0 on and off when testing the transistor circuit of Fig. 1. Hit any key on the keyboard to toggle the port to the opposite state. When the transistor circuit is plugged in, its output should swing between +5 to +15 V and −5 to −15 V for proper RS-232 operation.

Initialization Protocol

Once the data line is connected to the printer and the jumper is installed, the interface is finished. It is now a working system and ready for use. To start it up, there is a short initialization protocol that has to be repeated each time the printer is turned on. These steps may be performed manually, but with some creativity a routine could be written to perform them automatically. There are five steps:

- Run the printer subroutine in the Apple II.
- Apply power to the printer.
- Flip the line/local switch to the line position. The ready and proceed lights on the front of the Selectric will come on.
- Press the initiate key on the right side of the Selectric keyboard. The proceed light will turn off.
- Send an EOA code ($B4), which is the # character in the EBCD or BCD codes or the number 9 in the correspondence code.

Once this character is sent, the terminal is in the receive mode and ready to print.

Added Benefits

The final result of this project is that an RS-232C output port has been created at the annunciator 0 pin of the game paddle I/O connector. This article has harnessed that port for only one purpose, but there are others. For example, Paul Lutus has included a little-talked-about subroutine in his excellent word processing program, Apple Writer. This subroutine can be accessed by entering the word SERIAL in response to the Print Menu. Its purpose is to feed a serial-bit stream to the annunciator 0 port at one of five user-defined baud rates (110, 150, 300, 600 and 1200 bits per second).

There is no reason that the transistor circuit described in this article cannot be harnessed to output this ASCII coded information just as easily as it outputs the data streams coded for Selectrics. The ramifications of this are that high-speed serial input

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devices can also be connected for just 83 cents! In fact, this is the only way that Apple Writer can take full advantage of some printers.

Don't feel that the modification I have described here is limited to just printers—try plotters, modems, synthesizers or any other device that needs to receive RS-232C serial data from the Apple II.

The Reality of It All

The Selectric I purchased is a Carterfone S15B Data Terminal, which CFR Associates advertises for under \$500. It comes as is, which translates to: "it works, with quirks." Mine had a broken paddle on the line/local switch and I had to add a power cord. The folks at CFR (Box 144, Newton, NH 03858) have been helpful to me on the phone, and have been able to provide technical assistance in the form of a very lengthy manual about I/O electronics.

After several months of heavy use, the Selectric has earned its keep. So far it has not needed any repairs, but the good tend to die young, so it would probably be worth obtaining a repair manual to keep everything running smoothly. It is also a good idea to acquaint oneself with the local Selectric service personnel. They can supply new ribbons (even fancy carbon ribbons), type elements and answers to technical questions about the machine. Most advertise in the phone book.

One of the advantages of Selectrics is that they have a friction-feed platen. Individual sheets of paper or inexpensive newsprint paper rolls may be used. A good source of roll paper is the local radio station. They are provided reams of it from their newswire services and can usually part with several cases at a time (for free!). A modified toilet paper dispenser is just fine for holding the roll and centering it so that it does not "walk" back and forth on the carriage. And, if it is really needed, pin-feed platens may be purchased from service centers, giving you the best of both methods.

Conclusion

When I set out to build this interface, the primary motive was money. Now that I have had time to look back on it all, I realize that an even larger incentive was to expand the versatility of the Apple II via a grassroots effort. This microcomputer is tops in its class not just because of its design, but because owners and users have made imaginative use of its abilities.

If its users get too dependent on manufacturers to provide all of the expansion, the Apple II will quickly become outdated. On the other hand, as long as the users remain skilled in their craft, the Apple II will continue to dominate the market. Building this letter-quality printer interface makes investment in an Apple II the best choice you ever made.■

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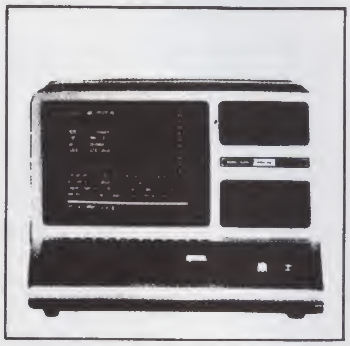

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Don't be a slob, be "pretty" when it comes to formatting BASIC listings.

Apple BASIC Prettyprinter

By Michael Keith

Many high-level languages available under large operating systems (e.g., Pascal, C or LISP) have access to a prettyprinting program to automatically reformat other programs in a specified way to render them more readable and understandable.

```
 10 REM  PROGRAM TO FIND ALL
 15 REM  PERFECT NUMBERS<N
 20 TEXT : CALL -936: VTAB 10: INPUT
    "WHAT VALUE OF N",N
 30 DIM PN(10):NUMPERF=1:PN(1)=
    1
 40 REM  MAIN LOOP
 50 FOR NUM=2 TO N:SUM=0
 60 FOR DIV=1 TO NUM-1: IF NUM MOD
    DIV=0 THEN SUM=SUM+DIV: NEXT
    DIV
 70 IF SUM#NUM THEN 90
 80 NUMPERF=NUMPERF+1:PN(NUMPERF)
    =NUM
 90 NEXT NUM
100 REM  PRINT NUMBERS
110 FOR I=1 TO NUMPERF: PRINT PN(
    I),: NEXT I
120 END
```

Sample 1a. Sample Integer BASIC program.

```
****************************************
   10 REM  PROGRAM TO FIND ALL
   15 REM  PERFECT NUMBERS<N
----------------------------------------
   20 TEXT :
      CALL -936:
      VTAB 10:
      INPUT "WHAT VALUE OF N",N
   30 DIM PN(10):
      NUMPERF=1:
      PN(1)=1
****************************************
   40 REM  MAIN LOOP
----------------------------------------
   50 FOR NUM=2 TO N:
         SUM=0
   60    FOR DIV=1 TO NUM-1:
            IF NUM MOD DIV=0
               THEN
            SUM=SUM+DIV:
         NEXT DIV
   70    IF SUM#NUM
            THEN
         90
   80    NUMPERF=NUMPERF+1:
         PN(NUMPERF)=NUM
   90 NEXT NUM
****************************************
  100 REM  PRINT NUMBERS
----------------------------------------
  110 FOR I=1 TO NUMPERF:
         PRINT PN(I),:
      NEXT I
  120 END
```

Sample 1b. Program in Sample 1a after prettyprinting.

This simple prettyprinter, written in BASIC, is for the Apple II. It uses the powerful disk operating system file commands to manipulate the BASIC source program into a form suitable for prettyprinting. The system accepts programs written in either type of Apple BASIC (Integer or Applesoft). You can use this prettyprinter for final documentation of your own programs or as a study tool for reading programs written by others.

A Description

First, you read your program into memory. Next, a short program is appended to the end and run. This program transfers your program into a text file on disk. You then run the main program, which reads in the text file and processes it to produce the prettyprinted output.

The features of the prettyprinter output include highlighting of groups of one or more REM statements, automatic breakup of multiple-statement lines and FOR-NEXT and IF-THEN indentation.

A sample program and the output generated by the prettyprinter are shown in Sample 1.

```
30000 D$=" ";REM CTRL-D

30005 PRINT D$;"OPEN LISTING":PRINT D$;
      "DELETE LISTING"

30010 PRINT D$;"OPEN LISTING":PRINT D$;
      "WRITE LISTING"

30020 POKE 33,30: LIST 1,30000

30030 PRINT D$;"CLOSE LISTING"

30040 END

RUN 30000

RUN PRINT
```

Listing 1. Contents of the text file APPRINT.

The prettyprinter program consists of two files, which must reside on the same diskette: a text file called APPRINT and an Applesoft program called PRINT. The contents of APPRINT are shown in Listing 1. This text file can be created by writing a short program which opens a file called APPRINT, prints these lines and closes the file (for a detailed description of text files, see the Apple DOS manual). To operate the prettyprinter, do the following:

1. Load the BASIC program you wish to prettyprint into memory.
2. Insert the diskette containing the prettyprint files and type EXEC APPRINT.

After doing this, the following sequence of events takes place:

1. The program lines in APPRINT are appended to the user program.
2. The RUN 30000 command puts the user program in a text file called LISTING.
3. The main program, PRINT, is executed.

The main program, PRINT, is given in Listing 2, which was produced by the prettyprinter itself as a sample of its output.

The most time-consuming section of the PRINT program is the initial reading in and preprocessing of the program (lines 1–65). This can take from half a minute to five minutes depending on the size of the program. During this stage, the program is separated into single statements, which are stored in array elements A$(1), A$(2) . . . A$(N). The user is then presented with a menu of functions: P for prettyprint, I for index or Q for quit.

Address correspondence to Michael Keith, D46 Abbington Drive, Hightstown, NJ 08520.

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SNOBOL: String manipulation language.
RUNFLO: Text formatting program (write resumes etc.).
RUNF10: Word processing and text formatting program (write resumes etc.).
CONCOR: Concordance generator. This program is very useful for documentation purposes. CONCOR reads an ASCII file and creates an output file which contains a line numbered listing of the original file, and a list of all the words contained in the file along with the numbers of the lines on which each word occurs (similar to an index).
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—Compound Growth Rates
RANNO: Random number generator.
XEDIT: XF4 binary file editor.

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As listed in Listing 2, the prettyprint option (P) will cause a hardcopy printout through an interface card in slot 2. To change to a different slot, merely change line 1001. To prettyprint to the video display only (the mode I usually use the program in), merely delete line 1001. In this mode, pressing any key on the keyboard can be used to pause and resume the listing at any point. The index option (I) produces a list of all REM statements in the program on the CRT. This is useful for locating a specific routine or for reading a program's documentation.

The formatting rules used by the prettyprinter follow:

1. A block of REM statements is highlighted as follows:

```
(blank line)
***************
(REM statements)
--------------
```

Exception: In a multiple-statement line whose first statement is *not* a REM, the blank line and the asterisks are suppressed.

2. FOR-NEXT loops are indented as follows:

```
FOR (expression)
   (              )
   ( statements   )
   (              )
NEXT
```

Loops within loops are indented further (once for each increase in nesting depth).

3. IF-THEN statements are reformatted as follows:

```
IF (expression)
   THEN
(              )
(  statements  )
```

Finally, note that a prettyprinted program is not executable BASIC. However, it is simple to reconvert a prettyprinted listing to legal BASIC. You merely delete the REM highlighting, group the multiple statements together and then write IF-THENs on one line.

Summary

I have described a simple prettyprinter for Apple II BASIC programs, but there are many possible enhancements. One of the most useful (and also one of the most difficult) enhancements is to recode parts of the program in machine language for increased speed. Nevertheless, the program presented here has proven a useful tool for better understanding of programs and their operation. The basic technique of capturing and manipulating a BASIC program as a text file can be used to produce more elaborate prettyprinters, conversion programs (e.g., to convert from one type of BASIC to another) or fancy program editors. These and other possibilities are left to you for further experimentation. ■

Listing 2. PRINT, the main prettyprinting program.

```
1       TEXT
        DIM A$(500)
2       :
****************************************
3       REM  READ IN PROGRAM FROM FILE 'L
        ISTING'
4       REM  AND BREAK INTO SINGLE STATEM
        ENTS
----------------------------------------
5       N = 1:
        D$ =  CHR$ (4):
        PRINT D$;"OPEN LISTING":
        PRINT D$;"READ LISTING"
8       A$(0) = "":
        C = 0
10      HOME :
        VTAB 10:
        PRINT "PROGRAM IS BEING READ IN A
        ND PROCESSED. "
20      GET A$
21      IF A$ =  CHR$ (13) AND  LEN (A$(N
        )) = 0
           THEN
        20
23      IF A$ =  CHR$ (13)
           THEN
        N = N + 1:
        A$(N) = "":
        C = 0:
        GOTO 50
25      IF A$ =  CHR$ (34)
           THEN
        C = C + 1
27      IF A$ = ":" AND  INT (C / 2) = C
        / 2
           THEN
        A$(N) = A$(N) + A$:
        N = N + 1:
        A$(N) = "":
        C = 0:
        GOTO 50
30      A$(N) = A$(N) + A$
40      IF A$(N) = "30000"
           THEN
        60
50      GOTO 20
60      PRINT D$;"NOMON":
        VTAB  PEEK (37):
        CALL  - 868
62      N = N - 1
65      PRINT D$;"CLOSE LISTING"
67      :
****************************************
68      REM  INITIAL FORMATTING
----------------------------------------
70      GOSUB 2000
72      :
****************************************
75      REM  NOW GO TO MAIN MENU
----------------------------------------
80      GOTO 500
95      :
****************************************
96      REM  A COLLECTION OF SUBROUTINES
97      REM  PLACED HERE FOR SPEED
100     REM  REM-CHECK
----------------------------------------
101     BFLAG = 0:
        EFLAG = 0
102     IF  MID$ (Z$,7,3) <  > "REM"
           THEN
         RETURN
110     IF  MID$ (Z$,11,1) <  > " "
           THEN
        Z$ =  LEFT$ (Z$,9) + " " +  RIGHT
        $ (Z$, LEN (Z$) - 9)
120     IF  MID$ (A$(I - 1),7,3) <  > "RE
        M" AND  LEFT$ (Z$,6) <  > "
        "
           THEN
        BFLAG = 1
130     IF  MID$ (A$(I + 1),7,3) <  > "RE
        M"
           THEN
        EFLAG = 1
139     IF BFLAG = 1
           THEN
         PRINT
140     IF BFLAG = 1
           THEN
         PRINT "**************************
        **************"
190     RETURN
199     :
****************************************
200     REM  IF-THEN CHECK AND PRINT
```

More

Listing 2 continued

```
210   IF  MID$ (Z$,7,2) <  > "IF"
        THEN
       RETURN
220   L$ = Z$
230   FOR J = 9 TO  LEN (Z$):
          IF  MID$ (Z$,J,4) = "
            THEN
           THEN 250
240   NEXT J
250   Z$ =  LEFT$ (L$,J - 1):
      GOSUB 405
260   PRINT  SPC( TB + 6 + 3);"THEN"
270   Z$ = "          " +  RIGHT$ (L$, LEN
      (L$) - 4 - J):
      GOSUB 405
275   IF  MID$ (L$,J + 6,3) = "FOR" OR
       MID$ (L$,J + 5,3) = "FOR"
        THEN
      TB = TB + 3
280   POP
      RETURN
399   :
****************************************
400   REM  FOLD AND PRINT Z$
----------------------------------------
402   GOSUB 100:
      REM  CHECK IF REM
----------------------------------------
403   GOSUB 200:
      REM  CHECK IF IF-THEN
----------------------------------------
405   IF  LEN (Z$) < 39 - TB
        THEN
       PRINT  LEFT$ (Z$,6); SPC( TB); R
      IGHT$ (Z$, LEN (Z$) - 6):
      GOTO 447
410   PRINT  LEFT$ (Z$,6); SPC( TB); MI
      D$ (Z$,7,39 - TB - 6);
      X = 40 - TB
420   L = X + 32 - TB:
      IF L >  LEN (Z$)
        THEN
      L =  LEN (Z$)
425   PRINT  SPC( TB + 6);
430   PRINT  MID$ (Z$,X,L - X + 1)
440   IF L =  LEN (Z$)
        THEN
       447
445   X = X + 33 - TB:
      GOTO 420
447   IF EFLAG = 1
        THEN
       PRINT "--------------------------
      ---------------"
448   RETURN
449   :
****************************************
500   REM  MAIN MENU
----------------------------------------
510   HOME :
      VTAB 3:
      PRINT "  ***  APPLE BASIC PRETTYP
      RINTER  ***"
520   VTAB 8:
      PRINT "    I - INDEX TO ALL REM ST
      ATEMENTS"
550   PRINT :
      PRINT "    P - PRINT PROGRAM"
565   PRINT :
      PRINT "    Q - QUIT"
580   VTAB 22:
      PRINT :
      GET A$
585   IF A$ = "Q"
        THEN
       END
590   IF A$ = "P"
        THEN
       GOSUB 1000:
      GOTO 500
591   IF A$ = "I"
        THEN
       GOSUB 1800:
      GOTO 500
599   GOTO 580
999   :
****************************************
1000  REM  PAGE LIST
----------------------------------------
1001  PR# 2
1002  TB = 0:
      REM  INITIALIZE TAB
----------------------------------------
1005  HOME
1010  FOR I = 1 TO N
         Z$ = A$(I):
         GOSUB 400
1030     IF  PEEK ( - 16384) > 127
           THEN
          POKE  - 16368,0:
         GET A$
****************************************
1040     REM  CHECK FOR NEW TAB (FOR OR
          NEXT)
----------------------------------------
1055     IF  MID$ (A$(I),7,3) = "FOR"
           THEN
         TB = TB + 3
1080     IF  MID$ (A$(I + 1),7,4) <  >
         "NEXT"
           THEN
         1089
1085     COUNT = 1:
         FOR Q = 5 TO  LEN (A$(I + 1))
1086        IF  MID$ (A$(I + 1),Q,1) =
            ","
              THEN
            COUNT = COUNT + 1
1087     NEXT Q
1088     TB = TB - 3 * COUNT
1089  NEXT I:
      PRINT
1090  VTAB 24:
      PRINT "PRESS ANY KEY FOR MAIN MEN
      U...";:
      GET A$:
      RETURN
1100  END
1799  :
****************************************
1800  REM  REM-INDEX
----------------------------------------
1810  HOME :
      VTAB 2:
      PRINT "      ###### REMARK INDEX #
      #####       "
1820  PRINT :
      FOR I = 1 TO N
1825     IF  MID$ (A$(I),7,3) <  > "REM
         "
           THEN
         1900
1828     T = 10
1830     IF  MID$ (A$(I),T,1) = " "
           THEN
         T = T + 1:
         GOTO 1830
1835     Z$ =  LEFT$ (A$(I),6) + " " +
          RIGHT$ (A$(I), LEN (A$(I)) -
         T + 1)
1838     GOSUB 400
1840     IF  PEEK (37) < 21
           THEN
         1900
1850     VTAB 24:
         PRINT "  PRESS RETURN FOR MORE
         , ESC TO QUIT ";
1860     GET A$:
         IF  ASC (A$) = 27
           THEN
          RETURN
1870     HOME
1900  NEXT I
1910  VTAB 23:
      PRINT "PRESS ANY KEY FOR MAIN MEN
      U...":
      GET A$:
      RETURN
****************************************
2000  REM  INITIAL FORMATTING
2001  REM  LEFT-JUSTIFIES LINE NUMBERS
      AND ALIGNS STATEMENT BEGINNINGS
----------------------------------------
2002  IF  LEFT$ (A$(1),1) = " "
        THEN
      TYP = 1:
      REM   TYP=1 MEANS INTEGER BASIC
----------------------------------------
2005  FOR I = 1 TO N
2010     A =  ASC ( LEFT$ (A$(I),1)) -
          ASC ("0")
2012     IF TYP = 0
           THEN
         2020
2013     K = 1
2014     IF  MID$ (A$(I),K,1) = " "
           THEN
         K = K + 1:
         GOTO 2014
2015     A =  ASC ( MID$ (A$(I),K,1)) -
          ASC ("0")
2016     IF A < 0 OR A > 9
           THEN
         2100
2017     GOTO 2200
2020     IF A < 0 OR A > 9
           THEN
         2100
2030     J = 1
2040     A =  ASC ( MID$ (A$(I),J,1)):
         A = A - 128 *  INT (A / 128):
         IF (A > 47 AND A < 58) OR A =
         32
           THEN
         J = J + 1:
         GOTO 2040
2045     IF J > 6
           THEN
         2200
2050     FOR K = J TO 6:
            A$(I) =  LEFT$ (A$(I),J - 1
            ) + " " +  RIGHT$ (A$(I), L
            EN (A$(I)) - J + 1):
         NEXT
2060     GOTO 2200
2100     J = 1
2110     A =  ASC ( MID$ (A$(I),J,1)):
         IF A = 32
           THEN
         J = J + 1:
         GOTO 2110
2120     A$(I) = "      " +  RIGHT$ (A$
         (I), LEN (A$(I)) - J + 1)
2200  NEXT I:
      X =  FRE (0):
      RETURN
```


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ENGINEERING AND PRODUCTION CONTROL SYSTEMS

Company founder and president, Walter L. Myers (right), pictured with production engineer Joe Zellers who developed the production control software for the MSI computer system.

THE COMPANY: MYERS SPRING COMPANY, INC. LOGANSPORT, INDIANA

Myers Spring Company, Inc. was founded 35 years ago by Walter L. Myers for the manufacture of small mechanical springs which are used widely in mechanical appliances, electrical equipment, and by the automotive, construction, and many other industries. The Myers Spring company has grown to several million dollars in annual sales and employs approximately 50 people in its production facility.

Production engineer Joe Zellers comments, "we began looking at computer systems approximately ten years ago in order to keep up with the increasing demand of order processing, custom mechanical spring design engineering, and production control. In 1975, we selected the MSI system because they were the first company in the microcomputer industry to offer the necessary peripherals which would convert a microcomputer system into a usable business system. Since 1975, the MSI system has been expanded to accommodate four users simultaneously, performing a variety of plant monitoring functions and management programs."

"The system is equipped with 10 megabytes of hard disk storage presently and we plan to add an additional 10 megabytes of storage soon. The maximum downtime has been only one or two days in the 5 years that the system has been in operation. MSI has provided excellent technical support and willingness to help us with our special requirements. We have nothing but praise for MSI, they have provided excellent system support."

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"All of the production at Myers Spring is performed to exact customer specifications rather than to the manufacture of standard spring products. This causes an ever increasing demand for quick and efficient design and engineering capabilities. Many parameters have to be taken into consideration in the design of any particular spring, including wire size, wire type, material modulus, spring diameter, number of turns per inch, free length, spring loading, rate, solid height, working stress, working temperature, number of operating cycles, hysteresis, resonant frequency, expansion, and whether the spring has to be ground or not. It used to take over an hour for an engineer to design a spring taking into account all of these parameters. However, with the engineering software which we have developed for the MSI system, spring design can be completed in less than one minute by simply keying in the desired parameters. The MSI computer system not only designs the spring for us but prepares a complete quotation for the customer after consideration of the material to be used, the amount of waste, which equipment the production will use, the speed of the machines, the necessary labor rate, as well as the desired percentage of profit."

One of four workstations where design engineering, checking of sales order status, and production control monitoring is performed.

SALES QUOTATION SYSTEM

Following the computer spring design procedure, with automatic quotation feature, the actual production begins. Each quotation is reviewed and compared to actual job cost reports on the production run in order to make any necessary refinements in the quotation system software. This feature of our system has greatly improved our ability to prepare accurate quotations and to insure profitability of the company.

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Each production work order is tracked by the computer system at each stage of the production process. First, each order is checked against the customer quotation for accuracy. As each order is processed, exact shop labor time is recorded, for each production machine used, and each stage of the production process. Summary reports are produced showing the total amount of material used, time used on each production machine, amount of material used, and a total cost figure for each work order.

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The system is designed to produce monthly sales summaries which show the amount of products sold by each salesman, complete with dates, order numbers, type of product, quantity, type of material, material cost, sales commissions, etc. Totals for each desired category and for each salesman are reproduced.

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Each morning, invoices are generated for orders which will be shipped that day. The accounts receivable system maintains accounts for over 500 active customers. The system produces monthly statements complete with aging of open invoices.

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The MSI system is equipped with four user terminals presently which are available for use simultaneously by the following departments: Order department, for entering new orders and checking order status. Inventory department, used for checking to see whether a particular product has been produced previously. Invoicing/Cost Accounting, used for preparation of invoices and for entry of labor and material cost accounting information. Design Engineering, used by company engineers to design new products.

Order entry, invoicing, monthly statements, and other management reports are carried out at this workstation at Myers Spring Co.

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The MSI system automatically prepares journals for cost accounting information and sales data which can then be posted to the general ledger. Complete income statements and balance sheets are produced by the general ledger programs on the system.

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The MSI system is used in many different areas of the company in order to provide more efficient and effective management of our production facilities. Several of the reports which we obtain from the system are: **production schedules, due list for orders, new orders list, production summary by department, salesman's reports, individual customer reports and order histories, time studies, sales quotations, design engineering, sales summaries, customer statements, general ledger balance sheet and income statements.**

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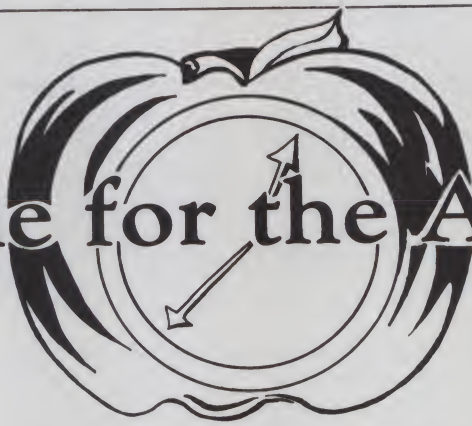
This article, along with recent developments in single-chip clock circuit design, simplifies the task of adding timekeeping ability to your Apple.



Time for the Apple

By David Goss

Computerists often find it useful to keep track of time. To fill this need you can buy Apple's ready-to-plug-in Clock/Calendar Card for around $280. Or, you might want to construct a versatile real-time clock/timer circuit card that will cost you only $50 to $60. It is designed for the Apple, but can be adapted to other systems by modifying the bus interface.

Our needs for timekeeping in computing generally fall into one of two categories. The first is interval timing; i.e., controlling or measuring the duration of an event, or the time between events. For example, computer-generated music and other sounds can be created by timing the interval between speaker pulses to determine pitch, and by timing the duration of each tone. You can do this with instruction loops, but using a hardware timer provides much greater accuracy and resolution, and does not require experimenting or cycle-counting to derive the number of instructions necessary for a desired time interval.

The second category involves the time-of-day and/or the date. Your computer might need a clock, for example, to determine when to turn lights or appliances in your computer-controlled home on or off, or to activate your modem to get the opening stock market reports while you catch an extra 40 winks. Functions of this sort are easily implemented with the help of a hardware clock.

You can make your timing device more useful by giving it the ability to generate interrupts to the processor. You can then set up a desired time function and put the processor to work doing other things until the interrupt occurs to indicate that the function is complete, rather than having to continuously monitor time.

Thanks to large-scale integrated circuits, you can make a clock, calendar, timer and interrupt processor with just two large-scale integration (LSI) circuits, to provide the following features:

- Time in hours, minutes and seconds
- 12- or 24-hour format
- Date in month, day and year
- Day of the week
- Programmable interrupts once every second, minute or hour
- Two programmable interval timers
- Battery operation while the computer is turned off

The LSI circuits are the OKI MSM5832 real-time clock/calendar and the 6522 versatile interface adapter.

Clock/Calendar

The MSM5832 is an 18-pin CMOS IC which provides the full range of clock/calendar functions. It features an on-chip 32,768 Hz crystal-controlled time base, which is counted down to provide addressable four-bit binary-coded decimal (BCD) data describing hours, minutes, seconds, year, month, date and day of week. Data access is controlled by a four-bit address and by chip select, read and write inputs. Table 1 shows the address selection codes. A hold input is also provided to prevent the internal registers from being counted down during read or write operations. Timing accuracy will not be affected by the hold input if it is active for less than one second at a time.

The circuit also provides pulse outputs at rates of 1024 Hz, once/second, once/minute and once/hour on the data lines under the conditions specified in Table 2. I'll describe the use of these outputs to generate interrupts later.

The clock may be programmed to operate in either 12- or 24-hour format. In the 12-hour format it provides an AM/PM indicator. The calendar will roll over correctly for 30-day and 31-day months, and can adjust for leap years. The latter requires that the leap year bit in register 8 be set prior to midnight of Feb. 28 in the leap year. The clock will count a 29th day in February, and will automatically reset to give 28-day counts in succeeding Februarys. The leap year bit thus requires setting once every four years.

The MSM5832 is too slow to interface directly with the Apple bus. The hold input, for example, must be active for a minimum of 150 us prior to a read or write, and address inputs must be stable for at least six us prior to a read. An interface buffer is therefore necessary.

Versatile Interface Adapter

I selected the 6522 as the bus interface device primarily for its timer and interrupt ability. A block diagram of the device is shown in Fig. 1. Its full capability is too extensive to describe here, but I will cover the major points of interest.

The 6522 provides two bidirectional eight-bit I/O ports, each line of which can be independently programmed by the corresponding data direction register to act as either an input or an output. There are also two

David Goss (2021 Kornat Drive, Costa Mesa, CA 92626) is an electronics engineer employed in the aerospace industry. He has been an Apple user for a year and a half, and enjoys both hardware and software design.

control lines associated with each port, with each control line (CA1, CA2, CB1, CB2) programmable via the peripheral control register as either an interrupt input or an output. The port B control lines can also be used as a serial port to/from the shift register.

There are two on-chip 16-bit timers whose operating modes are controlled by the auxiliary control register. Both timers operate by counting down from a preset value and set interrupt flags when the count reaches zero. Timer T1 counts down on the 1-MHz-system clock, and so can time intervals of from one to 65,535 us. It can operate in either a one-shot or free-running (repeating) mode.

Countdown values are stored in two eight-bit latches. In the free-running mode, the contents of these latches are automatically transferred to the counter each time the count reaches zero. The latches can be loaded while the timer is counting, thus letting you modify the timing interval "on the fly."

Timer T2 can be used as a second one-to-65,535 us interval timer, or can be programmed to count down on pulses applied to line 6 of port B. That feature is used in this clock circuit to count on the 1024 Hz output from the clock chip, thus giving a timing range of (approximately) one to 65,535 ms.

The 6522 can handle seven separate interrupts, one each from CA1, CA2, CB1, CB2, T1, T2 and the shift register. Each interrupt has a corresponding bit in each of two registers, the interrupt enable register and the interrupt flag register. The interrupts may be selectively enabled or disabled by setting the appropriate bits in the IER to 1 or 0, respectively.

When an interrupt condition is met, a specified flag bit in the IFR is set. Bit 7 of the IFR is also set when any of the flag bits are set. If a flagged interrupt is enabled, the 6522 will lower the interrupt request (IRQ) line, signalling the processor that the interrupt has occurred. Once set, the interrupt flags can be cleared directly by writing a 1 to that bit of the IFR, or indirectly as defined in Table 3.

Table 4 shows the address codes and functions of all 16 registers of the 6522.

Putting It All Together

The circuit schematic (Fig. 2) shows the interconnection of the MSM5832, 6522 and supporting circuitry, and the required connections to the Apple bus.

The lower four lines of port B and the upper four lines of port A on the 6522 are used as control outputs to the clock chip, while the lower four lines of port A are connected to the clock data lines. These lines are used as outputs when writing to the clock and as inputs when reading the clock. The CA2, CB1 and CB2 lines are also connected to the data lines so that the timing pulses on these lines (once/second, once/minute, and once/hour) can be used as programmable interrupts. The 1024 Hz signal from D0 of the 5832 is connected to the 6522's PB6 input for use in conjunction with timer T2, as described earlier.

In addition to the two main ICs, it is necessary in this circuit to provide the address decode for the 6522 chip select. The objective here is to use the 16 peripheral I/O addresses, which Apple has reserved for each card slot, to address the 16 6522 registers. These addresses are between \$C0n0 and \$C0nF, where n is the slot number plus \$8 (\$ indicates a hexadecimal number).

The Apple peripheral bus provides a decoded access signal (*device select*) for this purpose, but unfortunately, it becomes active coincident with the rising edge of the phase Ø clock. That is too late for the 6522, which requires that the register select and chip select lines be stable 180 ns prior to the clock. We can meet that requirement if we decode the chip select directly from the address bus as shown, using 74LS127 and 74LS130 gates. The gate connections shown in

Address				Internal Counter	Data				Data Range	
A_3	A_2	A_1	A_0		D_3	D_2	D_1	D_0		
0	0	0	0	sec lo					0-9	Set to zero regardless of input when written to
0	0	0	1	sec hi	*				0-5	
0	0	1	0	min lo					0-9	
0	0	1	1	min hi	*				0-5	
0	1	0	0	hr lo					0-9	
0	1	0	1	hr hi	▲	▲			0-1 0-2	D_2=1 for PM D_3=1 for 24 hr D_2=0 for AM D_3=0 for 12 hr
0	1	1	0	day of wk	*				0-6	
0	1	1	1	day lo					0-9	
1	0	0	0	day hi	*	▲			0-3	D_2=1 for 29 days in Feb
1	0	0	1	mo lo					0-9	
1	0	1	0	mo hi		*	*		0-1	
1	0	1	1	yr lo					0-9	
1	1	0	0	yr hi					0-9	

* Unused bits

▲ Bits used for AM/PM, 12/24 hr, and leap year

Table 1. Clock address codes. (From the March 1980 MSM5832 data sheets supplied by OKI Semiconductor, 1333 Lawrence Expressway, Santa Clara, CA.)

Conditions	Output	Frequency	Pulse Width
hold=low	D_0(1)	1024 Hz	50% duty
read=high	D_1	1 Hz	122.1 us
c.s.=high	D_2	1/60 Hz	122.1 us
A_0-A_3=high	D_3	1/3600 Hz	122.1 us

(1) 1024 Hz output is independent of hold input.

Table 2. Pulse outputs. (From the MSM5832 data sheets.)

Bit #	Set by	Cleared By
0	Active transition of the signal on the CA2 pin.	Reading or writing the A port Output Register (ORA) using address 0001.
1	Active transition of the signal on the CA1 pin.	Reading or writing the A Port Output Register (ORA) using address 0001.
2	Completion of eight shifts.	Reading or writing the Shift Register.
3	Active transition of the signal on the CB2 pin.	Reading or writing the B Port Output Register.
4	Active transition of the signal on the CB1 pin.	Reading or writing the B Port Output Register.
5	Time-out of Timer 2.	Reading T2 low order counter. Writing T2 high order counter.
6	Time-out of Timer 1.	Reading T1 low order counter. Writing T1 high order counter.

Table 3. Interrupt flag register. (From the Jan. 1978 SY6522 data sheets supplied by Synertex, PO Box 552, Santa Clara, CA.)

the schematic assume that you are installing the clock card in slot 4. Table 5 gives alternate connections for other slots.

The only other active circuit element required is the inverting circuit that drives the 5832 chip select line. This is necessary because a reset, which occurs when you turn the Apple on or press reset, causes the 6522 to go into a state in which all of the I/O lines are in the high-impedance input mode. Since these lines have internal pull-up resistors, they look at that point like logic 1 signals to the 5832 inputs, one of which is the hold line. A reset would therefore stop the clock.

By connecting the chip select as shown, you can deselect the 5832 when the reset occurs. In this condition the clock continues to count, since the hold and all other inputs are disabled. The next write or read to the clock card can then set the control inputs back to the proper states.

The battery provides power to keep the clock running when the computer is off. The specifications say that a minimum of 2.2 V are required in the standby mode, so a battery supply of about 3 V is adequate. The specified battery current is 30 microamps (maximum) at 3 V, but measurements on a couple of samples showed only 5 to 7 microamps. At that rate a wide range of batteries would be suitable, including some of the button cells used in watches and calculators. Rechargeable cells could be used of course, but, considering the low current drain and consequent long life available from nonrechargeable cells, I did not feel that recharging was worth the extra circuitry required.

The final choice of battery in my case boiled down to one which was readily available and easy to connect. Ease of connection was important

Register Number	RS Coding RS3	RS2	RS1	RS0	Register Desig.	Description Write	Read
0	0	0	0	0	ORB/IRB	Output Register "B"	Input Register "B"
1	0	0	0	1	ORA/IRA	Output Register "A"	Input Register "A"
2	0	0	1	0	DDRB	Data Direction Register "B"	
3	0	0	1	1	DDRA	Data Direction Register "A"	
4	0	1	0	0	T1C-L	T1 Low-Order Latches	T1 Low-Order Counter
5	0	1	0	1	T1C-H	T1 High-Order Counter	
6	0	1	1	0	T1L-L	T1 Low-Order Latches	
7	0	1	1	1	T1L-H	T1 High-Order Latches	
8	1	0	0	0	T2C-L	T2 Low-Order Latches	T2 Low-Order Counter
9	1	0	0	1	T2C-H	T2 High-Order Counter	
10	1	0	1	0	SR	Shift Register	
11	1	0	1	1	ACR	Auxiliary Control Register	
12	1	1	0	0	PCR	Peripheral Control Register	
13	1	1	0	1	IFR	Interrupt Flag Register	
14	1	1	1	0	IER	Interrupt Enable Register	
15	1	1	1	1	ORA/IRA	Same as Reg 1 Except No "Handshake"	

Table 4. 6522 address codes. (From the SY6522 data sheets.)

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26-4002
64K 1 Drive
$3440.00

26-4160 1 Drive Exp. $1034.00
26-4161 2 Drive Exp. 1574.00
26-4162 3 Drive Exp. 2114.00
26-4530 Scripsit II. 265.00
26-4512 Profile II. 162.00
26-4511 Visicalc II. 265.00
26-4501 Gen Ledger. 180.00
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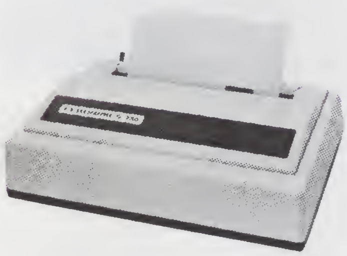

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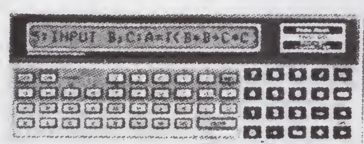

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26-3503 Cassette IF. 45.00
14-812 Recorder. 72.00

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26-1063 32K III
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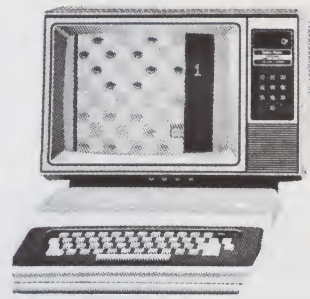

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Slot	Address	74LS27 9	74LS27 10	74LS27 11	74LS30 4	74LS30 5	74LS30 12
1	CO9x	GND	A5	A6	A4	A7	PUB
2	COAx	GND	A4	A6	A5	A7	PUB
3	COBx	GND	GND	A6	A4	A5	A7
4	COCx	GND	A4	A5	A6	A7	PUB
5	CODx	GND	GND	A5	A4	A6	A7
6	COEx	GND	GND	A4	A5	A6	A7
7	COFx	GND	GND	$\overline{A4}$*	A5	A6	A7

* requires inverting A4

Table 5. Chip select address decode.

because many candidate cells, such as the button types, require special clips or holders that are not generally available. My choice was a single 3 V alkaline cell (#532), which is available in camera shops. It features snap contacts, like those on 9 V transistor batteries, which provide a quick and positive connection. This battery should provide several years of service.

The diodes provide the required isolation between the battery and the computer's 5 V bus. Germanium diodes (1N270) were used because of their low (0.2 V) forward voltage drop. The series resistor is optional. I put it in just to provide some isolation to the battery in the event of a diode short.

Construction

The circuit was constructed on an Apple prototype card, using sockets for the ICs. You can take your choice of wiring method. I used solder connections with #30 solid conductor insulated wire-wrap wire. That type of wire is easily formed around the socket pins, solders easily, and will lie flat against the card even when there is excess length.

The only awkward part of building up the card is the battery mounting. If you use the suggested battery you will find that it can be mounted directly on the card, but will cause a tight fit with respect to the next higher card. You could eliminate that problem by using slot 7. Otherwise, if you put the battery on the card, be sure to insulate the case so that it won't short anything. My solution was to mount the battery on the inside of the computer case using a stick-on wire tie pad. A pair of wires then connect the battery to the card. Not elegant, but practical. One advantage is that a battery leak won't be likely to seriously damage anything.

There is one option not shown in the schematic that you may be interested in. The 5832 has an ADJ input (pin 15), which is shown connected to ground. If you wish, you can connect that pin through a momentary con-

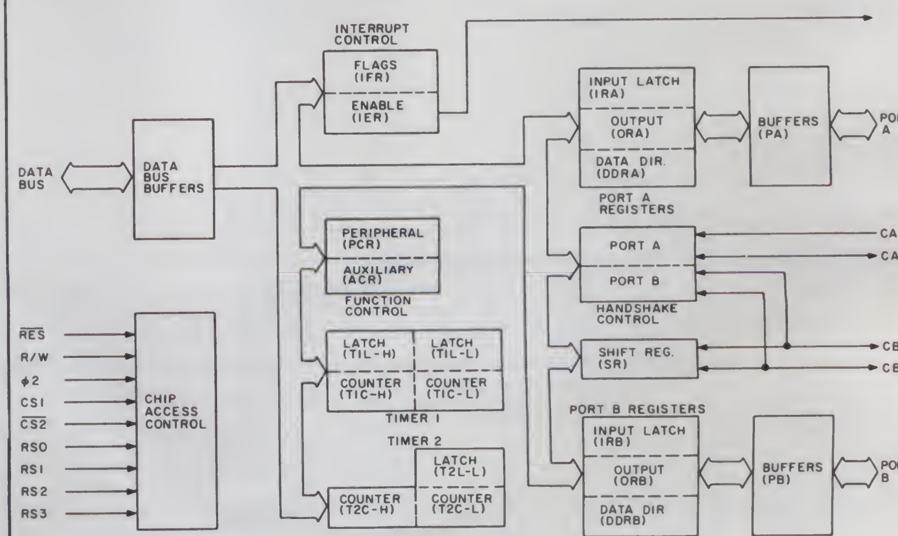

Fig. 1. SY6522 block diagram. (From the SY6522 data sheets.)

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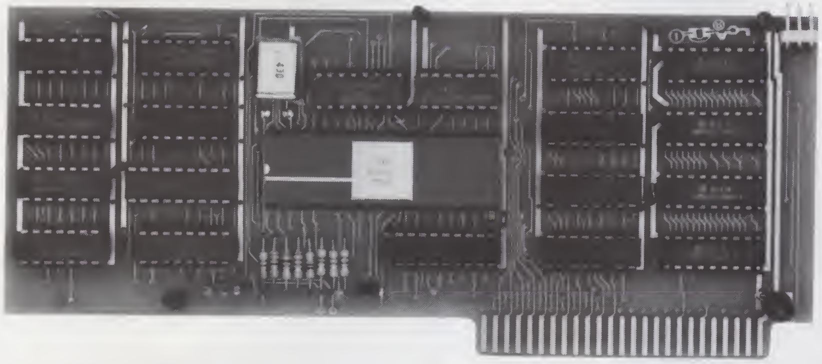

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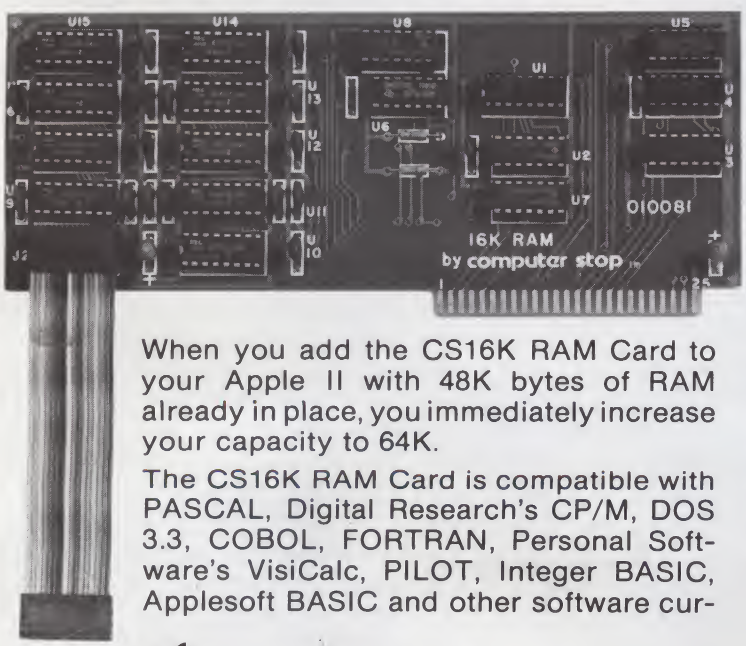

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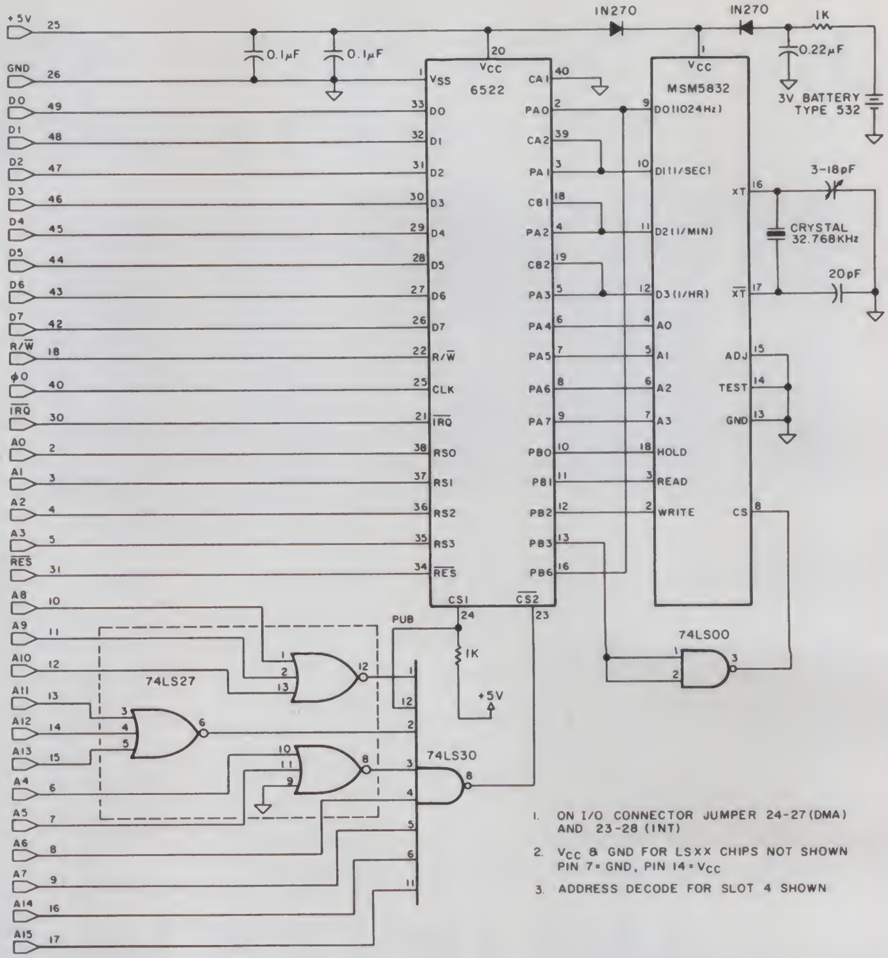

Fig. 2. Apple clock/calendar.

Listing 1. Set Clock routine.

```
10  REM  ************************
12  REM  *                      *
14  REM  *   SET CLOCK ROUTINE  *
16  REM  *   D.GOSS   22 AUG 80 *
18  REM  *                      *
20  REM  ************************
30 :
40  REM  * SET LY=1 TO ENAB LEAP YEAR OPTION
50 :
60 LY = 0
70 SLOT = 4
80 BA = 49280 + SLOT * 16: REM BASE I/O ADDR
90 RC = 39000: REM ADDR OF RD CLK PROG
92 :
94  REM  * ROUTINE EXITS WITH CLK/TIMER INTERRUPTS DISABLED
99 :
100 B$ =  CHR$ (7):D$ =  CHR$ (4)
110  PRINT D$;"BLOAD READ CLOCK"
120  HOME : VTAB 3
130  PRINT "ENTER TIME: HH MM"
140  VTAB 3: HTAB 13
150  INPUT "";T$
160 H1 =  VAL ( LEFT$ (T$,1))
180  IF H1 > 1 THEN 800
200 H2 =  VAL ( MID$ (T$,2,1))
210  IF H1 = 1 AND H2 > 2 THEN 800
220 N1 =  VAL ( MID$ (T$,4,1))
240  IF N1 > 5 THEN 800
260 N2 =  VAL ( MID$ (T$,5,1))
350  VTAB 5
360  INPUT "AM OR PM? ";M$
370  IF M$ <  > "AM" AND M$ <  > "PM" THEN  PRINT B$: GOTO 350
400  VTAB 7
410  PRINT "ENTER DATE: MM DD YY"
420  VTAB 7: HTAB 13
430  INPUT "";D$
440 M1 =  VAL ( LEFT$ (D$,1))
460  IF M1 > 1 THEN 850
480 M2 =  VAL ( MID$ (D$,2,1))
490  IF M1 = 1 AND M2 > 2 THEN 850
500 D1 =  VAL ( MID$ (D$,4,1))
520  IF D1 > 3 THEN 850
540 D2 =  VAL ( MID$ (D$,5,1))
550  IF D1 = 3 AND D2 > 1 THEN 850
560 Y1 =  VAL ( MID$ (D$,7,1))
580 Y2 =  VAL ( MID$ (D$,8,1))
600  PRINT
610  IF  NOT LY THEN 650
620  INPUT "LEAP YEAR? (Y/N) ";L$
650  PRINT : PRINT
660  INPUT "--- PRESS RETURN TO SET CLOCK ";A$
670  PRINT : PRINT
680  GOSUB 1000
690  PRINT "CLOCK NOW READS  ";: CALL RC: PRINT
700 :
710  POKE BA,0: REM RELEASE HOLD
```

More

Listing 1 continued.

```
720  PRINT : PRINT
730  END
799 :
800  REM * TIME INPUT ERROR
810  PRINT B$
820  GOTO 120
849 :
850  REM * DATE INPUT ERROR
860  PRINT B$
870  GOTO 400
999 :
1000  REM * SET TIME
1010 RA = BA + 1: REM ORA ADDR
1020  POKE BA + 14,127: REM DISAB INTERRUPTS
1030  POKE BA + 3,255: REM DDRA
1040  POKE BA + 2,15: REM DDRB
1050  POKE BA,1: REM SET HOLD
1060  IF M$ = "AM" THEN  POKE RA,80 + H1: REM  HR HI,AM
1070  IF M$ = "PM" THEN  POKE RA,84 + H1: REM  HR HI,PM
1080  GOSUB 2000
1090  POKE RA,64 + H2: REM HR LO
1100  GOSUB 2000
1110  POKE RA,48 + N1: REM MI LO
1120  GOSUB 2000
1130  POKE RA,32 + N2: REM MI HI
1140  GOSUB 2000
1150  POKE RA,16: REM SEC HI = 0
1160  GOSUB 2000
1170  POKE RA,0:: REM SEC LO = 0
1180  GOSUB 2000
1200  POKE RA,160 + M1: REM MO HI
1210  GOSUB 2000
1220  POKE RA,144 + M2: REM MO LO
1230  GOSUB 2000
1240  IF L$ < > "Y" THEN  POKE RA,128 + D1: REM DAY HI, NORM
1250  IF L$ = "Y" THEN  POKE RA,132 + D1: REM DAY HI, LEAP YR
1260  GOSUB 2000
1270  POKE RA,112 + D2
1280  GOSUB 2000
1290  POKE RA,192 + Y1: REM YR HI
1300  GOSUB 2000
1310  POKE RA,176 + Y2: REM YR LO
1320  GOSUB 2000
1330  RETURN
1999 :
2000  REM * WRITE DATA
2010  POKE BA,5: REM WRITE ON
2030  POKE BA,1: REM WRITE OFF
2040  RETURN
```

Listing 2. Read Clock routine.

```
0800                 ;
0800                 ;READ CLOCK ROUTINE
0800                 ;REAL TIME CLOCK CARD
0800                 ;SLOT 4
0800                 ;
0800                 ;VERSION 1.6
0800                 ;07 SEPT 80
0800                 ;
0800                 PRBL2   EQU  $F94A
0800                 IOSAVE  EQU  $FF4A
0800                 IOREST  EQU  $FF3F
0800                 WAIT    EQU  $FCA8
0800                 COUT    EQU  $FDED
0800                 IORB    EQU  $COC0
0800                 IORA    EQU  $COC1
0800                 DDRB    EQU  $COC2
0800                 DDRA    EQU  $COC3
0800                 H1OSAV  EQU  $047C
0800                 TDFLAG  EQU  $057C
0800                 ORBSAV  EQU  $067C
0800                 ;
9858                         ORG  $9858
9858                         OBJ  $0800
9858                 ;
9858  204AFF         ENTRY   JSR  IOSAVE        ;TIME/DATE ENTRY
985B  A900                   LDA  0
985D  8D7C05                 STA  TDFLAG
9860  F012                   BEQ  SETUP
9862  204AFF         TONLY   JSR  IOSAVE        ;TIME ONLY ENTRY
9865  A901                   LDA  1
9867  8D7C05                 STA  TDFLAG
986A  D008                   BNE  SETUP
986C  204AFF         DONLY   JSR  IOSAVE        ;DATE ONLY ENTRY
986F  A902                   LDA  2
9871  8D7C05                 STA  TDFLAG
9874  78             SETUP   SEI                ;DISAB 6502 IRQ
9875  ADCOCO                 LDA  IORB
9878  8D7C06                 STA  ORBSAV        ;SAVE ORB CONTENTS
987B  A9F0                   LDA  OFO
987D  8DC3C0                 STA  DDRA          ;PAO-PA3 IN,PA4-PA7 OUT
9880  A90F                   LDA  OF
9882  8DC2C0                 STA  DDRB          ;PBO-PB3 OUT,PB4-PB7 IN
9885  A901                   LDA  1
9887  8DCOCO                 STA  IORB          ;SET CLK HOLD
988A  A906                   LDA  6
988C  20A8FC                 JSR  WAIT          ;DELAY 150 USEC
988F  A903                   LDA  3
9891  8DCOCO                 STA  IORB          ;SET CLK HOLD & READ
9894                 ;
9894  AD7C05                 LDA  TDFLAG
9897  C902                   CMP  2             ;READ DATE ONLY?
9899  F05B                   BEQ  DATE          ;IF YES GO DATE
989B  A950                   LDA  50
989D  203999                 JSR  READ          ;READ HR HI
98A0  8D7C04                 STA  H1OSAV        ;SAVE BYTE
98A3  2903                   AND  3             ;MASK INVALID BITS OFF
98A5  204C99                 JSR  PRINT         ;PRINT HR HI
98A8  A940                   LDA  40
98AA  204399                 JSR  RD.PT         ;OUTPUT HR LO
98AD  A9BA                   LDA  OBA
98AF  20EDFD                 JSR  COUT          ;PRINT COLON
98B2  A930                   LDA  30
98B4  204399                 JSR  RD.PT         ;OUTPUT MIN HI
98B7  A920                   LDA  20
98B9  204399                 JSR  RD.PT         ;OUTPUT MIN LO
98BC  A9BA                   LDA  OBA
98BE  20EDFD                 JSR  COUT          ;PRINT COLON
98C1  A910                   LDA  10
98C3  204399                 JSR  RD.PT         ;OUTPUT SEC HI
98C6  A900                   LDA  0
98C8  204399                 JSR  RD.PT         ;OUTPUT SEC LO
98CB  A9A0                   LDA  OA0
98CD  20EDFD                 JSR  COUT          ;SPACE
```

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Listing 2 continued.

```
98D0 AD7C04          LDA H10SAV
98D3 6A              ROR
98D4 6A              ROR
98D5 6A              ROR
98D6 B008            BCS PRINTP        ;IF AM/PM IS PM PRINT "P"
98D8 A9C1            LDA OC1
98DA 20EDFD          JSR COUT          ;ELSE PRINT "A"
98DD 4CE598          JMP PRINTM
98E0 A9D0     PRINTP LDA OD0
98E2 20EDFD          JSR COUT          ;PRINT "P"
98E5 A9CD     PRINTM LDA OCD
98E7 20EDFD          JSR COUT          ;PRINT "M"
98EA          ;
98EA AD7C05          LDA TDFLAG
98ED C901            CMP 1             ;TIME ONLY?
98EF F032            BEQ EXIT          ;IF SO EXIT
98F1          ;
98F1 A202            LDX 2
98F3 204AF9          JSR PRBL2         ;2 SPACES
98F6 A9A0     DATE   LDA 0A0
98F8 204399          JSR RD.PT         ;OUTPUT MO HI
98FB A990            LDA 90
98FD 204399          JSR RD.PT         ;OUTPUT MO LO
9900 A9AF            LDA 0AF
9902 20EDFD          JSR COUT          ;PRINT SLASH
9905 A980            LDA 80
9907 203999          JSR READ          ;READ DAY HI
990A 2903            AND 03            ;MASK LEAP YR BITS OFF
990C 204C99          JSR PRINT
990F A970            LDA 70
9911 204399          JSR RD.PT         ;OUTPUT DAY LO
9914 A9AF            LDA 0AF
9916 20EDFD          JSR COUT          ;PRINT SLASH
9919 A9C0            LDA 0C0
991B 204399          JSR RD.PT         ;OUPUT YR HI
991E A9B0            LDA 0B0
9920 204399          JSR RD.PT         ;OUTPUT YR LO
9923          ;
9923 A9A0     EXIT   LDA 0A0
9925 20EDFD          JSR COUT          ;SPACE
9928 A9F0            LDA 0F0
992A 8DC1C0          STA IORA          ;CLK ADDR = $F
992D AD7C06          LDA ORBSAV
9930 290F            AND 0F            ;SET UNUSED BITS TO ZERO
9932 8DC0C0          STA IORB          ;RESTORE ORB
9935 203FFF          JSR IOREST        ;RESTORE 6502 REGISTERS
9938 60              RTS
9939          ;
9939          ;SUBROUTINES
9939          ;
9939 8DC1C0   READ   STA IORA          ;SET READ ADDR
993C EA              NOP
993D EA              NOP
993E EA              NOP               ;DELAY 6 USEC
993F ADC1C0          LDA IORA          ;READ DATA
9942 60              RTS
9943          ;
9943 8DC1C0   RD.PT  STA IORA          ;SET READ ADDR
9946 EA              NOP
9947 EA              NOP
9948 EA              NOP               ;DELAY 6 USEC
9949 ADC1C0          LDA IORA          ;READ DATA
994C          ;
994C 290F     PRINT  AND 0F            ;CLEAR BITS 4-7
994E 09B0            ORA 0B0           ;CONV TO ASCII
9950 20EDFD          JSR COUT          ;PRINT CHAR
9953 60              RTS
9954          ;
                     END
```

```
0800          ;
0800          ;CLOCK DEMO
0800          ;VERSION 1.1
0800          ;07 SEPT 80
0800          ;
0800          HOME    EQU $FC58
0800          IOSAVE  EQU $FF4A
0800          IOREST  EQU $FF3F
0800          IORB    EQU $C0C0
0800          IORA    EQU $C0C1
0800          DDRB    EQU $C0C2
0800          DDRA    EQU $C0C3
0800          PCR     EQU $C0CC
0800          IFR     EQU $C0CD
0800          IER     EQU $C0CE
0800          RDCLK   EQU $9858
0800          ;
9960                  ORG $9960
9960                  OBJ $0800
9960          ;
9960 78       ENTRY   SEI            ;DISABLE 6502 INTERRUPTS
9961 2058FC           JSR HOME
9964 A900             LDA #$00
9966 8DCCC0           STA PCR        ;PROG CA2 FOR INPUT, NEG ACTIVE EDGE

9969 A9F0             LDA #$F0
996B 8DC3C0           STA DDRA       ;ENABLE CLK ADDR OUTPUTS
996E 8DC1C0           STA IORA       ;SET CLK ADDR TO $F
9971 A90F             LDA #$0F
9973 8DC2C0           STA DDRB       ;ENABLE CLK CONTROL OUTPUTS
9976 A902             LDA #$02
9978 8DC0C0           STA IORB       ;TURN READ CMD ON
997B A981             LDA #$81
997D 8DCEC0           STA IER        ;ENABLE CA2 INTERRUPT
9980 A9A1             LDA #INTRPT
9982 8DFE03           STA $3FE       ;SET INTERRUPT VECTOR LO
9985 A999             LDA /INTRPT
9987 8DFF03           STA $3FF       ;SET INTERRUPT VECTOR HI
998A 58               CLI            ;ENABLE 6502 INTERRUPTS
998B 2C00C0   KEYIN   BIT $C000      ;CHECK FOR ANY KEY
998E 10FB             BPL KEYIN      ;IF NOT, CHECK AGAIN
9990 2C10C0           BIT $C010      ;ELSE CLEAR KEY STROBE
9993 A97F             LDA #$7F
9995 8DCEC0           STA IER        ;DISABLE 6522 INTERRUPTS
9998 A900             LDA #$0
999A 8DC0C0           STA IORB       ;TURN OFF READ CMD
999D 78               SEI            ;DISABLE 6502 INTERRUPTS
999E 4C69FF           JMP $FF69      ;RETURN TO MONITOR
99A1          ;
99A1 A909     INTRPT  LDA #$09
99A3 8524             STA $24        ;CENTER PRINTOUT ON CRT
99A5 205898           JSR RDCLK      ;OUTPUT TIME/DATE
99A8 A901             LDA #$01
99AA 8DCDC0           STA IFR        ;CLEAR CA2 INTERRUPT FLAG
99AD 40               RTI            ;RETURN
99AE          ;
                      END
```

Listing 3. Clock Demo.

tact switch to Vcc or to the pull-up resistor. Depressing the switch will then cause the clock's second-counter to reset to 0. The minute-counter will remain unchanged if the seconds count was less than 30, but will advance one minute if the seconds count was 30 or more.

I had some trouble locating all of the parts for the circuit, particularly the clock chip and crystal. I finally found that Advanced Computer Products (PO Box 17329, Irvine, CA 92713) had everything I needed.

Making It Play

The trimmer capacitor in the circuit provides a method of fine-tuning the oscillator for accuracy. Getting it set correctly will probably require some trial-and-error attempts over an extended period of time, but to start with, just set it at the midpoint and you should be close. When adjusting, you add capacitance to slow the clock down, and subtract to speed it up. The adjustment is sensitive, so use small increments. With a little patience you should be able to get it accurate to within one second/week or better.

To use the clock/calendar your programs must first set up the 6522 registers, and then write to or read from the 5832, one BCD digit at a time. Sample program listings are included to get you started. To understand how things work, it might be helpful to go through an explanation using the Set Clock program (Listing 1) as an example. This Applesoft program allows the clock and calendar to be set from the keyboard. It programs the clock in the 12-hour mode and includes a leap year option, but does not set day of week.

The actual clock setting routine begins at line 1000, using time and date variables input in lines 100 through 670. Line 1020 makes sure that all 6522 interrupts are disabled by writing a $7F to the IER. (Interrupts are selectively enabled/disabled by writing to the IER with a 1 or 0, respectively, in bit 7, and a 1 in each bit 0–6 that you want to change.)

Line 1030 puts a $FF in the DDRA, programming all eight lines of port A as outputs. Line 1040 writes $0F to DDRB, making the lower four lines (PB0–PB3) outputs and the upper four (which are not used in this operation) inputs. Line 1050 then writes $01 to output register B (ORB), causing line PB0 to apply the hold signal to the clock.

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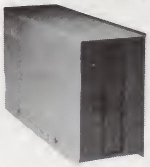

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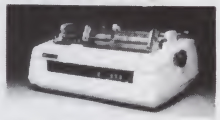

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```
40   REM ************************
50   REM *                      *
60   REM *   6522 T2 TIMER DEMO  *
70   REM *   D.GOSS    11 OCT 80  *
80   REM *                      *
90   REM ************************
99  :
100 SLOT = 4
102 BA = 49280 + SLOT * 16: REM BASE I/O ADDR
110 IR = 768: REM BASE ADDR, INTERRUPT ROUTINE
120 IV = 1022: REM BASE ADDR, INTERRUPT VECTOR
130 EI = 800: REM BASE ADDR, ENAB IRQ
200  DATA  32,58,255,167,127,141,205,192,64
210  FOR I = 0 TO 8: READ D
220  POKE IR + I,D: NEXT : REM LOAD INTERRUPT ROUTINE
240  POKE IV,0
250  POKE IV + 1,3: REM SET INTERRUPT VECTOR
280  HOME : VTAB 3
282  PRINT "THIS PROGRAM DEMONSTRATES OPERATION OF"
284  PRINT : PRINT "THE T2 TIMER BY SETTING AN ALARM TIMER."
286  PRINT : PRINT
290  INPUT "ENTER TIME IN SEC (63 MAX): ";T
300 T =  INT (T * 1024)
320 TH =  INT (T / 256):TL = T - TH * 256
330  POKE BA + 3,240
340  POKE BA + 1,240: REM CLK ADDR = $F
350  POKE BA + 2,15
360  POKE BA,2: REM SET READ CMD
370  POKE BA + 11,32: REM SET T2 PUSLE COUNT MODE
380  POKE BA + 14,160: REM  ENABLE T2 INTERRUPT
390  POKE BA + 8,TL: REM SET T2 LO
400  POKE BA + 9,TH: REM SET T2 HI
500  POKE EI,88
510  POKE EI + 1,96
520  CALL EI: REM ENABLE 6502 INTERRUPTS
530  PRINT : PRINT
540  PRINT "--- TONE WILL SOUND WHEN TIME EXPIRES"
550  PRINT
560  END
```

Listing 4. 6522 T2 Timer Demo.

Note that at this point we should allow a minimum delay of 150 us before writing data to the clock. The execution of BASIC is slow enough, however, that a separate delay statement is not required. Lines 1060 through 1320, in conjunction with the subroutine at line 2000, set the clock by writing one digit at a time.

The "POKE RA, —" statements set the appropriate clock address and data in output register A (ORA), following which the subroutine at 2000 loads the data into the clock by turning the write command on and then off. After all the data has been loaded, the program returns to line 690, which calls the machine-language Read Clock routine to read the clock and display the results for verification. Upon return the hold is released, allowing the clock to run normally.

Reading the Clock

The procedure for reading the clock is illustrated by the Read Clock routine (Listing 2), which prints the time and/or date on the screen or printer at the cursor location. Note that the routine starts at $9858 (39000), which is in the DOS 3.2 buffer space for a 48K system. It will be safe there assuming that MAXFILES is three (the normal value) and that there are not more than two files open at one time. Also note that the routine is written for slot 4. If you put your card in a different slot you will need to change the card address references.

It may be easier to understand the card's operation from the assembly listing because it exposes more detail than the BASIC listing does. The procedure is very much like that used to set the clock, except that DDRA is programmed so that lines PA0–PA3 are inputs rather than outputs. The time and date are read out one digit at a time, converted to ASCII, and output using the monitor's COUT subroutine.

On exit the clock address is set to $F, which is the address required to enable the timing pulse outputs. Note that the routine preserves the clock command status by saving the contents of output register B, and then restoring it prior to exit. The status of the read, write, hold and chip select lines will therefore be left unchanged.

A Clock Demonstration

The Clock Demo routine (Listing 3) is a short machine-language program which demonstrates the clock operation and the interrupt capability. The

circuit is programmed to generate an interrupt once/second, and on each interrupt the time and date are displayed using the Read Clock routine. Pressing any key will terminate the program and return control to the monitor.

The demonstration routine starts by setting the 6522 to enable the once/second interrupt, then sets the interrupt vector in $3FE and $3FF.

The circuit is inexpensive and relatively simple to construct, but offers a good measure of capability.

The interrupt routine itself starts at $99A1. It is a simplified routine in that only the once/second interrupt is expected. If multiple interrupts were enabled, it would be necessary to read the IFR and shift it right or left to determine which interrupt had occurred before taking further action. It would also be possible in that case for two or more interrupt flags to be set at the same time. Your program would then have to process them sequentially in accordance with whatever priority you set.

Using the Timers

The last program, Listing 4, is an Applesoft program that gives a simple demonstration of the 6522 timer capability. The program uses the T2 timer in the pulse counting mode, counting pulses from the 1024 Hz output of the 5832. The timer is set with a time value entered from the keyboard, and when the selected time interval expires, the timer generates an interrupt. The interrupt routine, which is poked into memory beginning at $300, beeps the speaker and then clears the interrupt flag by writing directly to the interrupt flag register.

Summary

The circuit described here is inexpensive and relatively simple to construct, but offers a good measure of capability. The programming examples only begin to explore potential applications. To fully understand all of the available operating modes, particularly of the timers, you should have a copy of the specifications on the 6522. The one that I have been using is published by Synertek, PO Box 552, Santa Clara, CA 95052. ■

Here's a cheap mod that lets you hear programs as you load the tape.

The Ten Cent Fix

By Don Lancaster

A ten-cent modification to a cassette recorder can dramatically improve its convenience and reliability as an I/O device for your computer.

Simply take the recorder apart and find the cassette's ear jack. Add a 470 ohm, ¼ watt resistor. Connect this resistor to the contacts on the ear jack, so that the speaker is driven through the resistor when something is plugged into the ear jack and is driven at normal volume when something is not (Fig. 1).

When you load a tape, the speaker will softly play back the tones as they go into your micro. This immediately tells you when your tone codes start and stop.

Better yet, with some practice, you'll be able to determine proper volume or tone settings and whether or not a tape is bad.

For some micros, including the Apple II, this "listen-quietly-to-the-tones-going-in" route lets you start the tone before you hit RETURN. This increases your chance of a good load, since it eliminates any glitches and pops before the tone starts.

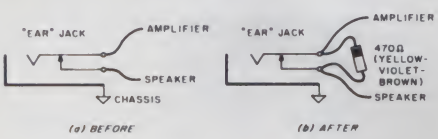


Fig. 1. Adding a resistor to the ear jack lets you softly hear programs as they load.

This idea only works on micros that have a long "preamble" or "locking tone" ahead of the actual data that's to be loaded.

Some Other Hints

Some tape recorders are fussy about how you connect them. A few demand a low resistance output load, such as the speaker, a headphone or a 100 ohm resistor. Disconnect these, and the internal amplifier feedback may give you a distorted, unusable output. Unless you know your recorder very well, it pays to put a 100 ohm load on your the recorder's input line. Often, just the "quiet listen" resistor you added will do the trick.

Other recorders are intolerant of a ground loop between ear output and auxiliary input. This can put extra hum and noise into your programs. In a few cheap recorders, connecting both at once can even short out the amplifier electronics. So, again, unless you know your recorder, it is unwise to connect both the ear and auxiliary cables at the same time. You can get around this by plugging in only one at a time, or you can add a switch that selects one or the other. Be sure to switch ground as well as the hot leads.

It's also a good idea to erase a tape *completely* before reuse. Should the old data start before you begin the new data, you'll get a glitch and an error message on the preamble almost every time.

Never record an "improved" program over the previous version. If anything goes wrong, you'll lose both old and new versions and have to reset to zero. Instead, use two tapes and alternate between them as you make improvements. Label your better improved versions. This way, if you have any problems, you only lose the most recent version, rather than everything you have done so far.

As a final hint, rewind your tapes before, rather than after, you use them. In this way, you can store your tapes with much less tension on them and prevent stretching. ■

With some practice, you'll be able to determine proper volume or tone settings and whether or not a tape is bad.

Don Lancaster
Synergetics

No matter how active or slow the trading is, this program will keep your portfolio up to date. Part 2.

Put Your Micro On Wall Street

By Dex Hart

TIMEGAIN is a short program which helps evaluate one or more stock portfolios over a specified period of time—a week, month, whatever. As written, it must be used with PORTVAL, described last month (but reprinted here), as all the data used is stored in PORTVAL and passed to TIMEGAIN with the Microsoft disk BASIC CHAIN command. (See "Put Your Micro on Wall Street," *Microcomputing*, July 1981, p. 126.) You could add READ-DATA lines to make the program stand alone, but the idea is to make portfolio updating easy—because if it isn't easy you probably won't do it (I'm assuming the rest of the world is as lazy as I am). I use these programs to follow several portfolios, and, while short and simple, they work.

The intent is twofold: to offer programs genuinely useful in portfolio bookkeeping and management and to demonstrate some aspects of Microsoft BASIC that appear to me to have been somewhat neglected. In last month's article the emphasis was on PRINT USING (and LPRINT USING) along with some elementary field arithmetic, especially how column totaling works. The second program, TIMEGAIN, chains to the original program and thus greatly simplifies data inputting. Note that CHAIN and COMMON are new to Microsoft BASIC as of version 5.0.

Target Group

I'm aiming this at those not-yet-expert BASIC programmers, a group in which I include myself. But I have learned some aspects of the language well, because I had to, and that limited area of acquired knowledge is what I'm sharing with you. You don't have to be a heavyweight investor to benefit from learning how these programs work, as the applications have wide general application.

I call TIMEGAIN a universal program, because it will work with any number of separate portfolio valuation programs and never has to be changed, updated or loaded with data.

PORTVAL Revisions

The revisions to last month's PORTVAL are slight. To distinguish the version with the CHAIN statement, I've called it PORTVAL.TWO. There are four revised lines and ten new ones. Lines 10, 310 and 550 are revised to reflect the program name change. Line 50 is revised to dimension for P1, the "old" share prices, since we now need stock prices for two different dates. New lines 182, 183 and 184 loop to read the old prices left in place as extra DATA. Note the remarks on the latter two of

PORTVAL.TWO.

```
10 REM *****   "PORTVAL.TWO"  ******
20 CLEAR
30 N=5
40 IF N<=10 GOTO 60
50 DIM A$(N),D$(N),S(N),C(N),P(N),P1(N),V(N),D(N),G(N)
60 RESTORE
70 FOR I=1 TO N
80 READ A$(I),D$(I),S(I),C(I)
90 NEXT I
100 DATA Carlisle, 29Sep80,160,9991
110 DATA Crown Cork,18Mar71,100,2231
120 DATA Humana," 7Mar77",900,4900
130 DATA Kysor,18Dec69,200,2758
140 DATA Travelers," 2Dec68",100,3511
160 FOR I=1 TO N
170 READ P(I)
180 NEXT I
181 READ D1$    'date of "new" prices—type w/o commas as item n+1
182 FOR I=1 TO N
183 READ P1(I)        'To update, input new prices ABOVE line 188;
184 NEXT I            'keep old prices on 188, delete 190, then RENUM
185 READ D2$    'date of "old" prices
188 DATA 85,32,74.8,10.4,39.3,21 Jan 81
190 DATA 84.0,28.4,71.4,10.6,38.9,30 Dec 80
194 PRINT "Complete this run before chaining TIMEGAIN."
195 INPUT "Want to run TIMEGAIN?  YES enter 1; NO hit return  ",W
196 IF W=1 THEN 197 ELSE 200
197 COMMON N,A$(),S(),P(),P1(),D1$,D2$
198 CHAIN "TIMEGAIN"
200 T1=0:T2=0:T3=0:T4=0
210 FOR I=1 TO N
220 V(I)=S(I)*P(I)
230 D(I)=V(I)-C(I)
240 G(I)=100*D(I)/C(I)
250 T1=T1+C(I)
260 T2=T2+V(I)
270 T3=T3+D(I)
280 T4=100*T3/T1
290 NEXT I
300 PRINT CHR$(12)        'clear screen
310 PRINT"'PORTVAL.TWO'......Portfolio Valuation.....prices as of ";D1$
320 PRINT
330 PRINT"    Stock         Date  Shares  Cost  Price  Value    Diff   %Gain"
340 PRINT
350 FOR I=1 TO N
360 PRINT USING"##  ";I;
```

More

Dex Hart (9414 SW 142 St., Miami, FL 33176) is a widely published boating writer.

these lines; I have not renumbered so as to avoid disturbing the original PORTVAL numbers, but when you do you will have to revise the line number references in these remarks.

There's an extra nonlooped READ line for the date of the "old" prices, D2$, since we will need both dates in TIMEGAIN to fully identify the span of time involved. Each date is listed as the final (n+1) item following n prices. If a large number of stocks is involved, and more than one DATA line is needed for each set of prices, the date also serves as a nice visual break between the two series of prices. Just remember to add the newest date as the final entry whenever entering prices. (The newest prices are on line 188; the former prices on 190.) The CHAIN-related commands are new lines 194–198.

TIMEGAIN has only 51 lines, but part of its compactness is in the method of writing PRINT USING. Compare the PRINT USING sections of PORTVAL.TWO and TIMEGAIN. Recognize that they do the same thing—format a whole line of string and numerical data, controlling location, decimal places and rounding. It is an extremely useful command system. Table 1 of last month's article lists the variables. Add to that P1, which is used in TIMEGAIN for share prices predating the current prices.

What we are doing in TIMEGAIN is to multiply the older price by the number of shares to get the "old" total cost, C; we then multiply the new prices, P, by the number of shares to get the current value of each stock, V. The dollar difference, D, is again V minus C, and the gain, G, is again the percentage gain or loss.

Listing continued.

```
370 PRINT USING"\         \  ";A$(I);
380 PRINT USING"\      \  ";O$(I);
390 PRINT USING"###  ";S(I);
400 PRINT USING"#####  ";C(I);
410 PRINT USING"##.#   ";P(I);
420 PRINT USING"#####   ";V(I);
430 PRINT USING"#####  ";O(I);
440 PRINT USING"####.#";G(I)
450 NEXT I
460 PRINT"****************************************************************"
470 PRINT "Totals";
480 PRINT TAB(29)USING" ######         ######   ";T1;T2;
490 PRINT USING"#####   ###.#";T3;T4
500 PRINT
510 INPUT "Hard copy?--YES enter 1 (printer on!)--NO hit RETURN  ",J
520 IF J=1 THEN 550 ELSE 540
530 GOTO 550
540 ENO
550 LPRINT"'PORTVAL.TWO'......Portfolio Valuation....Prices as of ";D1$
560 LPRINT
570 LPRINT"   Stock          Oate  Shares Cost  Price  Value    Oiff   %Gain"
580 LPRINT
590 FOR I=1 TO N
600 LPRINT USING"## ";I;
610 LPRINT USING"\         \  ";A$(I);
620 LPRINT USING"\      \  ";O$(I);
630 LPRINT USING"###  ";S(I);
640 LPRINT USING"#####  ";C(I);
650 LPRINT USING"##.#   ";P(I);
660 LPRINT USING"#####   ";V(I);
670 LPRINT USING"#####  ";O(I);
680 LPRINT USING"####.#";G(I)
690 NEXT I
700 LPRINT"****************************************************************"
710 LPRINT"Totals";
720 LPRINT TAB(28)USING" ######         ######   ";T1;T2;
730 LPRINT USING"#####   ###.#";T3;T4
740 GOTO 540
```

```
'PORTVAL.TWO'......Portfolio Valuation....Prices as of 21 Jan 81

   Stock          Date  Shares Cost  Price  Value    Diff   %Gain

 1 Carlisle     29Sep80  160   9991  85.0   13600    3609    36.1
 2 Crown Cork   18Mar71  100   2231  32.0    3200     969    43.4
 3 Humana        7Mar77  900   4900  74.8   67320   62420  1273.9
 4 Kysor       18Dec69  200   2758  10.4    2080    -678   -24.6
 5 Travelers    2Dec68  100   3511  39.3    3930     419    11.9
****************************************************************
Totals                         23391         90130   66739   285.3
```

PORTVAL.TWO sample run.

Program Differences

The difference is that while PORTVAL does its arithmetic on each stock from the purchase date of that stock, TIMEGAIN uses start and end dates which are the same for each stock. A glance at the sample runs of the two programs illustrates the difference and also shows how useful TIMEGAIN is. Last month's PORTVAL was as of Dec. 31, 1980. This month's PORTVAL.TWO is three weeks later, as of Jan. 21, 1981. The specific numbers are not greatly different between the two runs, and it is not immediately obvious where the greatest changes took place across that three weeks (the Dec. 31 %Gain, for example, was in order: 34.5, 27.3, 1211.4, −23.1, 10.8. Total gain, 270.0 percent).

But look at TIMEGAIN, which shows the gain only for that three-week period: Crown Cork had the largest move, three times that of Humana (although the Humana percentage gain has the most effect on the total gain, because it represents three-quarters of our arbitrary portfolio—a fact easily apparent since we have added a new column, percent of portfolio, to TIMEGAIN).

I keep a notebook titled, not surprisingly, "Portfolio." For any specific portfolio, I file each hard copy of PORTVAL, making notes on these copies of any transactions or items of special interest. I will occasionally run TIMEGAIN, normally as of the last trading day of each month. I receive an overall portfolio valuation from either program, but one shows my overall progress (not always encouraging), the other my current progress (also not always encouraging). But good news or not, you need to know how you're doing. If there's a problem, you won't solve it with your head in the sand. The main point: the two programs give different information—and both are useful.

How TIMEGAIN and Chaining Work

You don't want to load two sets of prices at a time; it doubles the work. So what you do is just leave the former prices in PORTVAL, although you won't use them there. At the next

update, you input the new prices before them (lower line number), and get rid of the really old prices by blanking the appropriate lines. This all takes place in PORTVAL. The remarks in lines 183 and 184 should make the process clear. The result is to always maintain two sets of prices of DATA, the newest first.

If you want to leave a particular set of prices in, such as the end-of-the-former-month prices, you don't do the renumbering business—just input the new prices on the new-price data lines, thereby (in this short portfolio example, on line 188) erasing the "intermediate" prices. When you want to run TIMEGAIN in the future, the start-period prices will be waiting for you (in this case, on PORTVAL line 190).

The whole idea is to never have to input more than a single set of prices at one time. It works just fine. There is a reminder in PORTVAL.TWO to finish its run first. That's because once you chain TIMEGAIN, you've lost PORTVAL. You could chain back, but why? Finish PORTVAL, print a hard copy if you choose, then run PORTVAL again and this time branch to the CHAIN operation when asked. TIMEGAIN will print to the screen and also offer you the hard-copy election.

If you want to pass all the variables, you just add a comma and the word ALL after CHAIN, without a COMMON statement. That seems wasteful so you just pass along the ones you need by using a COMMON statement (line 197) just before CHAIN. The variables specified will thus be common to each program. Note the format: Array variables are identified by a pair of empty parentheses. Note also that you only need to dimension the new variables you are calculating (see line 20)—not the ones being passed from the source program.

Inside TIMEGAIN, the new column, percent of portfolio, is identified by R. The "total" variables are basically the same, except that a fifth total has been added. T3 now becomes the "%Port" total—always 100 percent—stuck in the middle of the group.

So you transfer all the needed variables from PORTVAL: n, stock name, number of shares, new and old share prices and both dates. Move things about a bit, and you'll have a table full of new data.

Again I remind you that "PRINT CHR$(12)" is how I clear screen on my Superbrain. Your machine is probably different. "CLS" is a popular command. Or you might use a different CHR$ number.

Random Thoughts

Some final comments on documentation. We all know that the general level is bad. I believe Digital Research writes theirs in Chinese, but they recently sent me a mailing noting the existence of two CP/M books, Rodnay Zaks' *The CP/M Handbook* and *Using CP/M* by Judi Fernandez and Ruth Ashley. While Digital Research stops short of *recommending* these books, I don't. I have both and need both. Each covers material not covered in the other.

Microsoft's documentation is somewhat better than Digital Research's, but is far from prize-winning. Longer examples, a few more words and more clarity would make things so much easier. I haven't found a specific Microsoft book yet, although there is one aimed at Radio Shack's version of Microsoft. That's why I spent some time explaining PRINT USING, since it is difficult to figure out from documentation alone. I had to see a program using it. By outlining the full-line formatting function, perhaps I have done the same for you.

One final note: I never could figure out what WHILE-WEND meant. That is, I knew the WHILE meant "as long as," but WEND means to turn or proceed, right? You *wend* your way through? No clues from Microsoft (they don't answer letters either—at least not from me). Fortunately, I

TIMEGAIN program in Microsoft BASIC.

```
10 REM ***** TIMEGAIN ***** Universel Chain/Common Progrem
20 DIM C(N),V(N),R(N),D(N),G(N)
30 T1=0:T2=0:T3=0:T4=0:T5=0
40 FOR I=1 TO N
50 C(I)=S(I)*P1(I)
60 V(I)=S(I)*P(I)
70 D(I)=V(I)-C(I)
80 G(I)=100*O(I)/C(I)
90 T1=T1+C(I)
100 T2=T2+V(I)
110 T4=T4+D(I)
120 T5=100*T4/T1
130 NEXT I
140 FOR I=1 TO N
150 R(I)=100*V(I)/T2
160 T3=T3+R(I)
170 NEXT I
180 PRINT CHR$(12)
190 PRINT"'TIMEGAIN' Stock Velua Change Over Time—New prices as of ";O1$
200 PRINT TAB(42)"Old prices es of ";O2$
210 PRINT
220 PRINT"                          Old   Total   New   Currant"
230 PRINT"  Stock      Shares Price   Cost  Price   Value   %Port    Oiff   %Gain"
240 PRINT
250 FOR I=1 TO N
260 PRINT USING"## \        \ #### ###.#  ######  ";I;A$(I);S(I);P1(I);C(I);
270 PRINT USING"###.#  ######  ###.#   ######  ####.#";P(I);V(I);R(I);O(I);G(I)
280 NEXT I
290 PRINT"______________________________________________________________________"
300 PRINT "Totals";
310 PRINT TA8(27)USING"######         ######  ";T1;T2;
320 PRINT USING"###.#   ######  ####.#";T3;T4;T5
330 PRINT
```

More

came across a FORTRAN book and found the answer. The FORTRAN commands are WHILE and END WHILE. So simple when you see it—WEND is *WhilEND*. Why couldn't Microsoft have mentioned that?

Then there is the explanatory example Microsoft used. What kind of BASIC statements are WHILE FLIPS and FLIPS = 0? Long variable names? Something to do with sorting, a particular weak point with me—but then, I have no need to sort.

I'll find out someday, from somewhere or someone. And after all, would this whole business be so fascinating if it was without challenge?

For the Future

As soon as I dig out a full historical listing of the Consumer Price Index (CPI), I plan to work up another program, also chained to PORTVAL, which will apply the index to stock values, comparing how a portfolio has done in current dollars to how it has done in deflated dollars. The results will once more probably be discouraging, but better to know than to ignore. Sure hope I don't need FLIPS to make it work.■

Listing continued.

```
340 INPUT "Herd copy?—YES enter 1 (printer on!)—NO hit RETURN  ",J
350 IF J=1 THEN 370 ELSE 360
360 END
370 LPRINT"'TIMEGAIN' Stock Velue Chenge Over Time—New prices es of ";D1$
380 LPRINT TAB(42)"Old prices es of ";D2$
390 LPRINT
400 LPRINT"                          Old    Totel   New   Current"
410 LPRINT"   Stock      Shares Price    Cost  Price    Velue   %Port     Diff   %Gein"
420 LPRINT
430 FOR I=1 TO N
440 LPRINT USING"## \          \ #### ###.#  ######  ";I;A$(I);S(I);P1(I);C(I);
450 LPRINT USING"###.#  ######  ###.#   ######  ####.#";P(I);V(I);R(I);D(I);G(I)
460 NEXT I
470 LPRINT"***********************************************************************"
480 LPRINT"Totels";
490 LPRINT TAB(27)USING"######          ######  ";T1;T2;
500 LPRINT USING"###.#   ######  ####.#";T3;T4;T5
510 GOTO 360
```

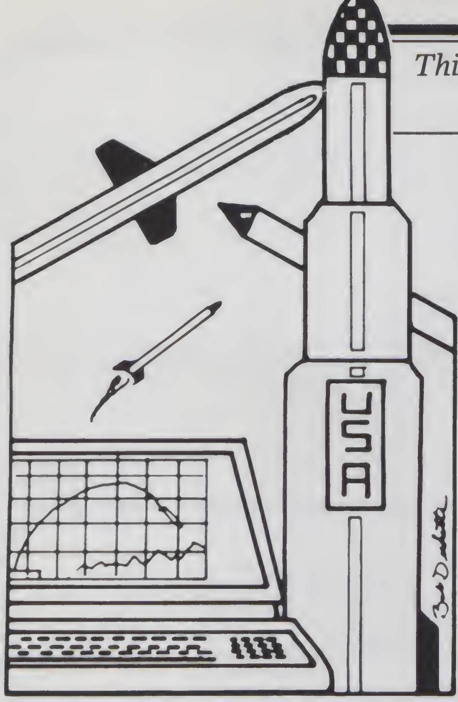
```
'TIMEGAIN' Stock Velue Chenge Over Time—New prices es of 21 Jen 81
                                        Old prices es of 30 Dec 80

                        Old    Totel   New    Current
   Stock         Shares Price   Cost   Price   Velue    %Port    Diff   %Gein

 1 Cerlisle       160   84.0   13440   85.0   13600    15.1     160     1.2
 2 Crown Cork     100   28.4    2840   32.0    3200     3.6     360    12.7
 3 Humene         900   71.4   64260   74.8   67320    74.7    3060     4.8
 4 Kysor          200   10.6    2120   10.4    2080     2.3     -40    -1.9
 5 Trevelers      100   38.9    3890   39.3    3930     4.4      40     1.0
*****************************************************************************
Totels                          86550          90130   100.0    3580     4.1
```

TIMEGAIN sample run.

See List of Advertisers on page 194



This program gives a lift to aerospace engineering and shows that micros can save time and money in high-technology endeavors.

TRS-80 Launchpad

By Terry L. Sunday

Most major aerospace missile system contractors have an advanced engineering concepts or preliminary design group whose purpose is to analyze the defense marketing environment and define new or modified weapon systems. They often must develop performance requirements of conceptual missile designs or characterize the abilities of existing missile systems used in new applications.

Until recently, the techniques to do this have been limited. Laborious hand calculations and pocket calculators cost time and accuracy, since many simplifying assumptions had to be made to reduce a problem to manageable size.

Existing missile simulation computer programs running on corporate mainframe systems, such as a CDC 7600 or IBM System 370, also presented problems. The data is used mainly to show the feasibility of a certain missile system concept, which requires that the system be simulated in enough detail for the results to be valid, but not in such detail that every nut and bolt is defined. Thus, full-blown mainframe simulations typically have far more capability than necessary. Also, the cost of generating data is very important, and cranking out a lot of numbers at a rate of $30 per CPU-second can quickly deplete an annual computer budget.

Enter the Microcomputer

A missile preliminary design group can now own a dedicated computer that will support its engineering analyses. Ready machine access and straightforward programming encourage use of such a computer in a wide variety of tasks. And best of all, after the initial system purchase, mountains of data can be generated at no cost to the user.

The program described here is for a TRS-80 Model I Level II, with 32K, two 5-1/4-inch disk drive units, a line printer and a power line filter assembly. The power line filter was necessary because of the system's sensitivity to line fluctuations, which was particularly apparent in the morning and afternoon hours when most employees arrived at or left the plant. The program is written in Level II BASIC and occupies about 10,500 bytes of memory.

The Program

The program is a two-degree-of-freedom (pitch-plane) missile trajectory simulation, and simulates the flight of a missile following launch either from the ground or from an aircraft. A completely arbitrary missile configuration may be used, so the same program is useful for many different analyses.

The missile may or may not have a rocket motor, and if it does, the motor is characterized by arbitrary thrust, ignition time, burn time and propellant weight. Of course, the motor parameters must be internally consistent. The missile configuration itself is defined by weight, size and aerodynamic characteristics. A flat, nonrotating earth is assumed, as well as an exponential atmosphere model. The flat earth assumption has proven to be quite acceptable for the short ranges involved in all program utilization to date.

The program output consists of a tabular listing of missile range, altitude, flight path angle and velocity, all presented as a function of time. This output can be selected to appear either on the CRT display or in hardcopy form on the line printer.

Listing 1 is the current version of the program, which will be discussed in detail later. Table 1 shows the input parameters required by the program. Note that the input parameters are divided for convenience into missile configuration data, initial conditions, control parameters and aerodynamic characteristics. The aerodynamic data required is expressed as axial and normal force coefficients, as a function of Mach number and angle of attack, in missile body axes. Provisions are included to use both power on (rocket motor burning) and power off (rocket motor not burning) data sets. The differences between power-on and power-off aerodynamic data may be important in some applications. An option lets you use only power-off data, a simplification that may frequently be employed without introducing significant error. In that case, a data flag is set which bypasses the requirement to provide power-on data.

Details of the program structure may be seen by examining Listing 1. Lines 60 through 90 establish the array dimensions and assign values to

Terry L. Sunday (3005 Devils Tower, El Paso, TX 79904) is a staff engineer with Martin Marietta Aerospace.

various physical and atmospheric model constants. Lines 110 through 590 contain the data input routine.

In the present version, a separate disk file, using DATA statements and with its first line number greater than the highest simulation program line number (5000 is typically used), must be established. The simulation program is first loaded into the computer, and the MERGE command is then used to attach the data file to the end of the program. This technique lets you set up multiple data sets, each representing a different missile configuration. Note the extensive use of integer array subscripts, as identified by the % character, to help speed up program execution.

Lines 530 through 590 let you change any of the data items before running the program, or between the runs in a series. Lines 620 through 650 permit the output option—either CRT or line printer—to be chosen, and lines 660 through 690 let you input a descriptive alphanumeric title that will appear as a heading on the printout. Lines 700 through 890 set up the initial values for various parameters used in the integration loop.

The actual integration loop runs from line 940 to line 2170. It is within this loop that all of the missile trajectory computations are performed. A trapezoidal integration scheme is used, with the time interval for integration steps defined by the input variable DT. A value of .5 second for DT is usually adequate.

Lines 970 through 1040 establish the exponential atmosphere parameters as a function of missile altitude, and determine the instantaneous missile Mach number for entry into the aerodynamic data tables. Lines 1050 through 1290 contain a routine which modifies the computation interval to force an integration to be performed at the discontinuities represented by rocket motor ignition or burnout, which need not occur exactly coincident with a normal integration step. A forced line print also occurs at these times.

The heart of the integration loop lies between lines 1320 and 1780. Here the forces acting on the missile are computed on each pass through the loop. This portion of the program is divided into two segments—the region from line 1340 to line 1550 is used when the rocket motor is burning, and the region from line 1560 to line 1780 is used when the motor is not burning. Each segment uses the appropriate table of power-on or power-off aerodynamic data, and if no power-on data is provided, the portion from line 1340 to line 1550 is bypassed. In either case, a double linear interpolation on both Mach number and angle of attack is used to produce as a final result the net drag and lift forces to which the missile responds. These forces are then used to determine missile longitudinal and lateral accelerations in lines 1790 and 1800, and then to update the missile velocity and position in lines 1810 through 1910. These are then used as starting conditions for the next pass through the loop.

The routine between lines 1920 and 2110 forces a line print at rocket motor ignition and burnout. If the line printer output option is selected, these lines are identified by the word "ignition" or "burnout" printed to the right side of the basic tabular output. On the CRT output, no such identifier is presented.

Lines 2120 and 2130 check to see whether the stopping conditions—either maximum time or cutoff altitude—are satisfied, in which case the program transfers to one of two termination routines. Lines 2210 through 2540 contain the output logic. This routine prints identifying headings on the columns of output data, conditions the missile trajectory data into the units employed for output and prints the data either on the CRT or printer.

A line of data output is triggered by any of the following three conditions: an incremental time period defined by the input value for print interval, PT, is reached; either ignition or burnout of the rocket motor occurs; or either of the program stopping conditions is satisfied. If a stopping condition is satisfied, the routine defined by lines 2550 through 2780 is executed, which causes the reason for program termination to be printed, along with the final trajectory conditions existing at that point.

Finally, lines 2790 through 2830 cause the program to prepare to execute again by returning the data pointer to the top of the data array, and asking the user if he desires to make another run. If the response is yes, program control transfers back to line 580, where any changes to the data set are made, and the cycle reinitiates.

TIME (SEC)	RANGE (KM)	ALTITUDE (AGL) (FT)	FLIGHT PATH ANGLE (DEG)	VELOCITY (FT/SEC)
0	0	175	26. 9926	1834
1	. 48781	974. 742	26. 0916	1729. 01
2	. 945972	1695. 84	25. 1341	1606. 87
3	1. 37628	2343. 1	24. 0958	1500. 48
4	1. 78235	2923. 77	22. 9745	1407. 01
5	2. 16711	3443. 73	21. 7685	1324. 04
6	2. 53284	3907. 65	20. 4758	1249. 35
7	2. 88141	4319. 39	19. 0938	1182. 14
8	3. 21476	4682. 63	17. 6207	1123. 21
9	3. 53485	5000. 78	16. 0571	1072. 02
10	3. 84361	5276. 87	14. 4053	1028. 29
11	4. 14273	5513. 4	12. 6698	991. 078
12	4. 4337	5712. 4	10. 856	959. 446
13	4. 71764	5875. 39	8. 96993	932. 071
14	4. 99531	6003. 49	7. 0172	907. 941
15	5. 2673	6097. 6	5. 00297	886. 679
16	5. 53407	6158. 44	2. 93282	868. 008
17	5. 79602	6186. 66	. 812846	851. 699
18	6. 05345	6182. 81	-1. 35034	837. 431
19	6. 30657	6147. 36	-3. 54999	824. 984
20	6. 55558	6080. 78	-5. 77913	814. 274
21	6. 80061	5983. 48	-8. 03042	805. 221
22	7. 04179	5855. 89	-10. 2962	797. 749
23	7. 27924	5698. 38	-12. 5686	791. 783
24	7. 51304	5511. 34	-14. 8399	787. 245
25	7. 74327	5295. 16	-17. 1023	784. 059
26	7. 97	5050. 21	-19. 3484	782. 145
27	8. 19326	4776. 9	-21. 5711	781. 423
28	8. 4131	4475. 63	-23. 7638	781. 808
29	8. 62954	4146. 81	-25. 9208	783. 216
30	8. 8426	3790. 89	-28. 0367	785. 557
31	9. 0523	3408. 32	-30. 107	788. 743
32	9. 25862	2999. 58	-32. 128	792. 685
33	9. 46158	2565. 19	-34. 0965	797. 293
34	9. 66116	2105. 66	-36. 0103	802. 476
35	9. 85734	1621. 58	-37. 8677	808. 146
36	10. 0501	1113. 51	-39. 6677	814. 215
37	10. 2394	582. 092	-41. 4097	820. 598
38	10. 4253	27. 9639	-43. 0938	827. 213
38. 049	10. 4343	0	-43. 1742	827. 543

FLIGHT TERMINATED AT CUTOFF ALTITUDE

Sample run.

```
D = MISSILE DIAMETER (INCHES)
W0 = MISSILE LAUNCH WEIGHT (POUNDS)
WF = MISSILE BURNOUT OR FINAL WEIGHT (POUNDS)  NOTE: MAKE SAME AS LAUNCH  WEIGHT
FOR UNPOWERED MISSILE.
BT = MOTOR BURN TIME (SEC)  NOTE: MAKE 0 IF NO MOTOR.
TT = MOTOR AVERAGE (CONSTANT) THRUST (POUNDS)  NOTE: MAKE 0 IF NO MOTOR.
BD = MOTOR IGNITION DELAY AFTER T0 (SEC)


INITIAL CONDITIONS

H0 = INITIAL ALTITUDE ABOVE GROUND LEVEL (FT)
R0 = INITIAL RANGE (KM)
V0 = INITIAL VELOCITY (FT/SEC)
G0 = INITIAL FLIGHT PATH ANGLE (DEGREES) POSITIVE UPWARDS
T0 = INITIAL TIME (SEC)
AG = GROUND ALTITUDE (FT)


CONTROL PARAMETERS

TF = MAXIIMUM FLIGHT TIME (SEC)
HF = CUTOFF ALTITUDE ABOVE GROUND LEVEL (FT)  NOTE:  CUTOFF WILL OCCUR  ONLY  IF
MISSILE IS DESCENDING WHEN REACHING THIS ALTITUDE
DT = INTEGRATION STEP SIZE (SEC)
PT = PRINT INTERVAL FOR HARD COPY OR SCREEN DISPLAY (SEC)
TC(1) = TIME TO INITIATE CONSTANT ANGLE OF ATTACK FLIGHT MODE (SEC)
TC(2) = TIME TO TERMINATE CONSTANT ANGLE OF ATTACK FLIGHT MODE (SEC)
AC = CONSTANT ANGLE OF ATTACK (DEGREES)  NOTE: TC(1) AND TC(2) MUST  BE  GREATER
THAN ZERO
OI% = POWER ON DATA FLAG:  IF 0, NO POWER ON DATA
                           IF 1, READ POWER ON DATA


AERODYNAMIC CHARACTERISTICS

NM% = NUMBER OF MACH NUMBERS TO BE LOADED (POWER OFF)  MAXIMUM 15
NA% = NUMBER OF ANGLES OF ATTACK TO BE LOADED (POWER OFF) MAXIMUM 10
M(1) TO M(NM%) = MACH NUMBER VALUES (POWER OFF)
A(1) TO A(NA%) = ANGLE OF ATTACK VALUES (DEGREES) (POWER OFF)
CA(M,A)  =  AXIAL  FORCE  COEFFICIENT  AS A FUNCTION OF MACH NUMBER AND ANGLE OF
ATTACK (POWER OFF)
CN(M,A)  =  NORMAL  FORCE  COEFFICIENT AS A FUNCTION OF MACH NUMBER AND ANGLE OF
ATTACK (POWER OFF)
O0% = NUMBER OF MACH NUMBERS TO BE LOADED (POWER ON) MAXIMUM 15
A0% = NUMBER OF ANGLES OF ATTACK TO BE LOADED (POWER ON) MAXIMUM 10
M0(1) TO M0(O0%) = MACH NUMBER VALUES (POWER ON)
A0(1) TO A0(A0%) = ANGLE OF ATTACK VALUES (DEGREES) POWER ON
C0(M0,A0)  =  AXIAL  FORCE COEFFICIENT AS A FUNCTION OF MACH NUMBER AND ANGLE OF
ATTACK (POWER ON)
N0(M0,A0)  =  NORMAL FORCE COEFFICIENT AS A FUNCTION OF MACH NUMBER AND ANGLE OF
ATTACK (POWER ON)
```

Table 1. Variable identification.

The missile used in the Sample run was fired at an angle of 30 degrees with an initial velocity of 1834 ft./sec., and did not use a rocket motor. The configuration actually represents a guided artillery projectile which has been under development for some time, and which was chosen as a test case because a large body of performance data exists which was used to verify the programming of the major equations of motion.

In this example, the projectile fired with the specified initial conditions hit the ground at a range of 10.43 km from the launch point following a ballistic flight of 38.049 seconds duration. These values are extremely close to those obtained by running a complete (and costly) six-degree-of-freedom projectile simulation on a System 370. The value of this TRS-80 simulation becomes immediately apparent.

The program has also to date been used to study performance abilities for a cannon-launched rocket-propelled guided projectile, and for a guided missile launched from an aircraft under a variety of flight conditions.

Modifications

Several changes may be made in the future. An option to simulate constant angle-of-attack glide is currently included in the program, but has not been sufficiently checked out to assure that it is completely debugged. A proportional navigation guidance scheme to simulate target engagements would add immeasurably to the program, and a simplified mechanization could be incorporated fairly easily.

Another useful modification would be to add the third degree of translational freedom, cross-range, so the effect of crosswinds and other lateral disturbances could be assessed.

Finally, a major effort is anticipated to reduce program execution time by streamlining the logic wherever possible. In its present form, one second of simulated flight requires about five seconds of real time with an integration interval of 0.5 second, and

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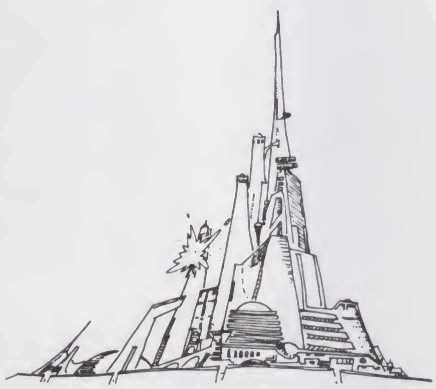

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this is approaching the point wherein interactive sessions become too time-consuming, due to the wait required for execution to be completed.

During program development, we found that the CRT output option was used very infrequently, so consideration is being given to removing this option entirely, with a consequent reduction in computation time and much simplification of the complex output logic. Use of a BASIC compiler rather than the existing BASIC interpreter would greatly improve execution time.

Conclusion

This article has presented a snapshot of a TRS-80 program that has proven to be very useful in aerospace engineering analyses. Program development is not complete, and probably never will be, because there is always another option to add. Nevertheless, even in its present state, it has served to demonstrate important new capabilities of the current crop of microcomputers, and to illustrate once again that these machines are far more than sophisticated video games. ■

Listing 1. Missile Flight Simulation program for the TRS-80 Model I, Level II.

```
10       '"PROGRAM FILESPEC IS TESTSIM                    VERSION 6/27/80
20  '"A TRAJECTORY SIMULATION FOR AIR OR GROUND-LAUNCHED MISSILES
30  '"
40  '"INITIALIZATION
50  '"
60  DIM M(15),A(10),CA(15,10),CN(15,10),TA(2),TC(2),X(5),D(4),E(4)
70  DIM M0(15),A0(10),C0(15 10),N0(15,10)
80  F1=0: G=32.174: PI=3.1415926: RD=0.01745329: R1=20855531. : C=.01874342
90  FI=.00694444: AZ=518.67: AY=0.00356616: AX=2116.2162: AW=0.00058256: AV=49.0221958E
100 '"
110 '"DATA INPUT
120 READ D,W0,WF,BT,TT,BD  '"PHYSICAL PARAMETERS"
130 READ H0,R0,V0,G0,T0,AG  '"INITIAL CONDITIONS"
140 READ TF,HF,DT,PT,TC(1),TC(2),AC  '"CONTROL PARAMETERS"
150 '"AERODYNAMIC COEFFICIENTS"
160 READ NM%,NA%
170 FOR K%=1 TO NM%
180 READ M(K%):  '"MACH NUMBER"
190 NEXT K%
200 FOR K%=1 TO NA%
210 READ A(K%):  '"ANGLE OF ATTACK"
220 NEXT K%
230 FOR I%=1 TO NM%
240 FOR J%=1 TO NA%
250 READ CA(I%,J%):  '"AXIAL FORCE COEFFICIENT - POWER OFF"
260 NEXT J%
270 NEXT I%
280 FOR I%=1 TO NM%
290 FOR J%=1 TO NA%
300 READ CN(I%,J%):      '"NORMAL FORCE COEFFICIENT - POWER OFF"
310 NEXT J%
320 NEXT I%
330 READ OI%
340 IF OI%=0 THEN 520
350 READ OO%,AO%
360 FOR K%=1 TO OO%
370 READ M0(K%)
380 NEXT K%
390 FOR K%=1 TO AO%
400 READ A0(K%)
410 NEXT K%
420 FOR I%=1 TO OO%
430 FOR J%=1 TO AO%
440 READ C0(I%,J%)        '"AXIAL FORCE COEFFICIENT - POWER ON"
450 NEXT J%
460 NEXT I%
470 FOR I%=1 TO OO%
480 FOR J%Q=1 TO AO%
490 READ N0(I%,J%)        '"NORMAL FORCE COEFFICIENT - POWER ON"
500 NEXT J%
510 NEXT I%
520 CLS
530 IF F1=1 THEN 580
540 INPUT "DO YOU WANT TO EDIT THE DATA FOR THE FIRST RUN Y/N";E$
550 IF E$="Y" THEN 580
560 GOTO 600
570 IF F1=0 THEN 600
580 PRINT "INPUT NEW DATA AND TYPE CONT TO RUN"
590 STOP
600 D1=DT: FF%=0: PF%=0: SF%=0: TP=PT: TR=TT
610 CLS
620 INPUT "DO YOU WANT A HARD COPY Y/N";A$
630 IF A$="N" THEN 660
640 PRINT "TURN ON LINE PRINTER AND TYPE CONT TO CONTINUE"
650 STOP
660 ON ERROR GOTO 680
670 GOTO 690
680 PRINT "TOO MANY CHARACTERS IN TITLE - TRY AGAIN"
690 INPUT "TYPE IN RUN TITLE";T$
700 SR=PI*((D[2)/4)*FI
710 W=W0
720 A5=0
730 IF TR=0 THEN 760
740 BR=(W0-WF)/BT
750 '"MATRIX INITIALIZATION"
760 X(1)=R0
```

More

Listing 1 continued.

```
770 RG=R0
780 X(2)=H0+AG
790 AL=X(2)
800 X(3)=G0*RD
810 GA=X(3)*57.28
820 X(4)=V0
830 X(5)=T0
840 T=T0
850 V=X(4)
860 D(1)=V*COS(X(3))             '"XDOT"
870 D(2)=V*SIN(X(3))             '"ZDOT"
880 D(3)=-G*COS(X(3))/V          '"GAMMADOT"
890 D(4)=-G*SIN(X(3))            '"VDOT"
900 GOTO 2270
910 '"
920 '"INTEGRATION LOOP STARTS HERE"
930 '"
940 FOR I%=1 TO 4
950 E(I%)=D(I%)
960 NEXT I%
970 Z=X(2)
980 H=R1*Z/(R1+Z)
990 T3=AZ-AY*H
1000 P=AX/((AZ/T3)[(C/AY))
1010 R=AW*P/T3
1020 A1=AV*SQR(T3)
1030 M1=X(4)/A1
1040 Q1=0.5*R*(X(4)[2)
1050 IF TT=0 THEN 1250
1060 IF X(5)<(T0+BD) THEN TR=0 ELSE TR=TT
1070 IF X(5)>=(T0+BD+BT) THEN TR=0
1080 IF X(5)<(T0+BD) THEN 1250
1090 IF X(5)>=(T0+BD) AND FF%=0 THEN 1110
1100 IF X(5)>=(T0+BD+BT) THEN 1160
1110 IF FF%=1 THEN 1230
1120 XD=X(5)
1130 X(5)=(T0+BD)
1140 FF%=1
1150 GOTO 1220
1160 IF FF%=2 THEN 1280
1170 XD=X(5)
1180 X(5)=(T0+BT+BD)
1190 FF%=2
1200 DT=X(5)-XD+D1
1210 GOTO 1280
1220 DT=X(5)-XD+D1
1230 W=W0-(BR*X(5)-BD)
1240 GOTO 1290
1250 W=W0
1260 GOTO 1290
1270 TR=0
1280 W=WF
1290 M=W/G
1300 IF TC(1)<X(5)<TC(2) THEN A5=AC ELSE A5=0
1310 IF X(5)<TC(1) OR X(5)>TC(2) THEN A5=0
1320 IF AC=0 THEN A5=0
1330 IF OI%=0 OR TR=0 THEN 1560
1340 Q%=1
1350 GOTO 1370
1360 Q%=Q%+1
1370 IF A5>=A0(Q%) THEN 1360
1380 P%=Q%-1
1390 K%=1
1400 GOTO 1420
1410 K%=K%+1
1420 IF M1>M0(K%) THEN 1410
1430 J%=K%-1
1440 S1=(M1-M0(J%))/(M0(K%)-M0(J%))
1450 C6=N0(J%,P%)+S1*(N0(K%,P%)-N0(J%,P%))
1460 C7=N0(J%,Q%)+S1*(N0(K%,Q%)-N0(J%,Q%))
1470 C8=C6+(C7-C6)*(A5-A0(P%))/(A0(Q%)-A0(P%))
1480 L=Q1*SR*C8
1490 C1=C0(J%,P%)+S1*(C0(K%,P%)-C0(J%,P%))
1500 C2=C0(J%,Q%)+S1*(C0(K%,Q%)-C0(J%,Q%))
1510 C3=C1+(C2-C1)*(A5-A0(P%))/(A0(Q%)-A0(P%))
1520 DR=Q1*SR*C3
1530 ND=(TR-DR)*COS(A5*RD)-L*SIN(A5*RD)
1540 NL=(TR-DR)*SIN(A5*RD)+L*COS(A5*RD)
1550 GOTO 1790
1560 Q%=1
1570 GOTO 1590
1580 Q%=Q%+1
1590 IF A5>=A(Q%) THEN 1590
1600 P%=Q%-1
1610 K%=1
1620 GOTO 1640
1630 K%=K%+1
1640 IF M1>M(K%) THEN 1630
1650 J%=K%-1
1660 S1=(M1-M(J%))/(M(K%)-M(J%))
1670 C6=CN(J%,P%)+S1*(CN(K%,P%)-CN(J%,P%))
1680 C7=CN(J%,Q%)+S1*(CN(K%,Q%)-CN(J%,Q%))
1690 C8=C6+(C7-C6)*(A5-A(P%))/(A(Q%)-A(P%))
1700 L=Q1*SR*C8
1710 C1=CA(J%,P%)+S1*(CA(K%,P%)-CA(J%,P%))
1720 C2=CA(J%,Q%)+S1*(CA(K%,Q%)-CA(J%,Q%))
1730 C3=C1+(C2-C1)*(A5-A(P%))/(A(Q%)-A(P%))
1740 DR=Q1*SR*C3
1750 IF TT=0 THEN ND=-DR*COS(A5*RD)-L*SIN(A5*RD)
1760 IF TT=0 THEN 1780
1770 ND=(TR-DR)*COS(A5*RD)-L*SIN(A5-RD)
1780 NL=(TR-DR)*SIN(A5*RD)+L*COS(A5*RD)
1790 D(4)=-G*SIN(X(3))+ND/M
1800 D(3)=-G*COS(X(3))/V+NL/(M*V)
1810 LG=X(3)
```

More

Listing 1 continued.

```
1820 LV=X(4)
1830 LR=X(1)
1840 LA=X(2)
1850 LT=X(5)
1860 X(3)=X(3)+0. 5*DT*(D(3)+E(3))
1870 X(4)=X(4)+0. 5*DT*(D(4)+E(4))
1880 D(1)=X(4)*COS(X(3))
1890 D(2)=X(4)*SIN(X(3))
1900 X(1)=X(1)+0. 5*DT*(D(1)+E(1))
1910 X(2)=X(2)+0. 5*DT*(D(2)+E(2))
1920 IF X(5)=(T0+BD) THEN 1950
1930 IF X(5)=(T0+BD+BT) THEN 2030
1940 GOTO 2110
1950 IF TT=0 THEN 2110
1960 IF A$="N" THEN 1990
1970 LPRINT X(5);TAB(15)(X(1)/3280. );TAB(31)X(2);TAB(47)(X(3)*57. 28);TAB(63)X(4);"   IGNITION"
1980 GOTO 2000
1990 PRINT USING F$; X(5),(X(1)/3280. ),X(2),(X(3)*57. 28),X(4)
2000 DT=D1-DT
2010 IF DT=0 THEN DT=D1
2020 GOTO 2120
2030 IF TT=0 THEN 2110
2040 IF A$="N" THEN 2070
2050 LPRINT X(5);TAB(15)(X(1)/3280. );TAB(31)X(2);TAB(47)(X(3)*57. 28);TAB(63)X(4);"   BURNOUT"
2060 GOTO 2080
2070 PRINT USING F$; X(5),(X(1)/3280. ),X(2),(X(3)*57. 28),X(4)
2080 DT=D1-DT
2090 IF DT=0 THEN DT=D1
2100 GOTO 2120
2110 DT=D1
2120 IF X(5)>=TF THEN 2220
2130 IF X(2)<(HF+AG) AND X(3)<0 THEN 2550
2140 IF X(5)>=TP THEN 2210
2150 X(5)=X(5)+DT
2160 V=X(4)
2170 GOTO 940
2180 '"INTEGRATION LOOP ENDS HERE"
2190 '"OUTPUT LOGIC FOLLOWS"
2200 '"
2210 TP=TP+PT
2220 T=X(5)
2230 RG=X(1)/3280.
2240 AL=X(2)
2250 GA=X(3)*57. 28
2260 V=X(4)
2270 IF A$="Y" THEN 2410
2280 IF SF%=1 THEN 2350
2290 CLS
2300 PRINT T$
2310 PRINT
2320 PRINT TAB(5)"TIME";TAB(13)"RANGE";TAB(20)"ALTITUDE";TAB(31)"GAMMA";TAB(38)"VELOCITY"
2330 PRINT TAB(4)"(SEC)";TAB(14)"(KM)";TAB(22)"(FT)";TAB(31)"(DEG)";TAB(38)"(FT/SEC)"
2340 SF%=1
2350 IF T>=TF THEN 2710
2360 IF AL<(HF+AG) AND GA<0 THEN 2550
2370 F$="######. ##"
2380 AP=AL-AG
2390 PRINT USING F$; T,RG,AP,GA,V
2400 GOTO 2150
2410 IF T>=TF THEN 2710
2420 IF AL<(HF+AG) AND GA<0 THEN 2550
2430 IF PF%=1 THEN 2520
2440 PF%=1
2450 LPRINT TAB(5)T$
2460 LPRINT " "CHR$(10)
2470 LPRINT " "CHR$(10)
2480 LPRINT TAB(2)"TIME";TAB(16)"RANGE";TAB(31)"ALTITUDE";TAB(47)"FLIGHT PATH";TAB(63)"VELOCITY
2490 LPRINT TAB(32)"(AGL)";TAB(50)"ANGLE"
2500 LPRINT TAB(2)"(SEC)";TAB(16)"(KM)";TAB(33)"(FT)";TAB(50)"(DEG)";TAB(63)"(FT/SEC)"
2510 LPRINT " "CHR$(10)
2520 AP=AL-AG
2530 LPRINT T;TAB(15)RG;TAB(31)AP;TAB(47)GA;TAB(63)V
2540 GOTO 2150
2550 AL=HF+AG
2560 X(2)=ABS(X(2))
2570 DI=(LA-(HF+AG))/(LA-X(2))
2575 T=X(5)-DT+(DT*DI)
2580 RG=(LR+((X(1)-LR)*DI))/3280.
2590 GA=(LG+((X(3)-LG)*DI))*57. 28
2600 V=LV+((X(4)-LV)*DI)
2610 AP=AL-AG
2620 IF A$="Y" THEN 2670
2630 PRINT USING F$; T,RG,AP,GA,V
2640 PRINT
2650 PRINT "FLIGHT TERMINATED AT CUTOFF ALTITUDE"
2660 GOTO 2790
2670 LPRINT T;TAB(15)RG;TAB(31)AP;TAB(47)GA;TAB(63)V
2680 LPRINT " "CHR$(10)
2690 LPRINT TAB(15)"FLIGHT TERMINATED AT CUTOFF ALTITUDE"
2700 GOTO 2Z90
2710 IF A$="Y" THEN 2760
2720 PRINT USING F$; T,RG,AP,GA,V
2730 PRINT
2740 PRINT "FLIGHT TERMINATED ON MAXIMUM TIME"
2750 GOTO 2790
2760 LPRINT T;TAB(15)RG;TAB(31)AP;TAB(47)GA;TAB(63)V
2770 LPRINT " "CHR$(10)
2780 LPRINT TAB(15)"FLIGHT TERMINATED ON MAXIMUM TIME"
2790 F1=1
2800 RESTORE
2810 T$=" "
2820 INPUT "DO YOU WANT TO MAKE ANOTHER RUN";R$
2830 IF R$="Y" THEN 580
2840 END
```

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Plunging deep into the heart of the steaming ROM jungle.

An Atari Disassembler

By William L. Colsher

When a new computer is introduced, we hobbyists are naturally curious about how it operates. How does it use RAM? Are undocumented features buried in the ROMs? What tape recording format does it use? To answer these questions requires patience and experience; digging through the ROMs and the reserved work areas requires a tool. That tool is the disassembler.

A disassembler is the opposite of an assembler. Instead of generating machine code as output, it accepts machine code and produces assembly-language listings as output. Naturally, the original labels aren't reproduced, but the result is a lot easier to use than a hex dump.

Because a disassembler is the opposite of an assembler, you would naturally expect that the two programs would be similar in structure. You would hope to see tables of machine operation codes (op codes), mnemonics, addressing modes and instruction lengths. The tables are used in much the same way as an assembler would use them but in the opposite direction. For example, a disassembler takes the op code and generates a mnemonic, while an assembler accepts a mnemonic and generates an op code.

If you now look at the program listing, you'll see that all these tables are, in fact, defined in line 100. A$(168) is a string containing the mnemonics. OC(151) is an array that holds the op codes. CD(151) combines with LN(13) to provide the information on addressing modes and instruction lengths. CD(151) also holds a pointer for each op code into the A$ string to enable the computer to find the correct mnemonic. The DATA statements in lines 30000 through 30310 are read to fill these tables.

To save space this program combines the pointer to the mnemonic table with the addressing mode. Table CD contains four-digit numbers: the first two digits are the mnemonic number and the second two are the addressing mode. The addressing mode points into the array LN, which contains the lengths of the instructions using the various addressing modes.

How It Works

Now let's take a look at how the disassembler works. In the listing,

Program listing.

```
100 DIM A$(168),B$(3),OC(151),CD(151),F$(4),H$(4),D$(1),T$(4),LN(13)
110 FOR I=1 TO 56
120 READ B$
130 A$((I-1)*3+1)=B$
140 NEXT I
150 FOR I=1 TO 151
160 READ A,B
170 OC(I)=A:CD(I)=B
180 NEXT I
190 FOR I=1 TO 13:READ A:LN(I)=A:NEXT I
200 GRAPHICS 0
210 PRINT "Enter all input in hexidecimal"
220 PRINT "Dis-assemble from:";
230 INPUT F$
240 PRINT "                  to:";
250 INPUT T$
260 H$=F$:GOSUB 10000:F=INT(H)+1:IF H=0 THEN F=0
270 H$=T$:GOSUB 10000:T=INT(H)+1:IF H=0 THEN T=0
280 GRAPHICS 0
290 POSITION 2,23
1000 REM ***START DIS-ASSEMBLY LOOP
1010 B=PEEK(F)
1020 GOSUB 10100
1030 IF ISOP THEN GOSUB 2000
1040 IF  NOT (ISOP) THEN GOSUB 3000
1050 IF F<=T THEN GOTO 1010
1060 PRINT "DIS-ASSEMBLY COMPLETE"
1070 PRINT "PRESS RETURN TO CONTINUE"
1080 INPUT H$
1090 GOTO 200
2000 REM ***DISPLAY AN INSTRUCTION
```

More

Address correspondence to William L. Colsher, 1711 Robin Lane, Lisle, IL 60532.

lines 100 through 290 perform all the necessary setup functions: filling the tables from the DATA statements and getting the start and end addresses from the user.

Lines 1000 through 1090 form the main loop of the program. After getting a byte to be disassembled, the subroutine at line 10100 is called. If the byte is an operation code, the subroutine beginning at line 2000 is called to display it. If the byte is *not* an op code, the subroutine at line 3000 is called. Both of these routines increment the pointer into memory F as appropriate. The loop continues until F is greater than or equal to T (the highest location to be disassembled).

Line 2000 begins the section of code that actually performs the disassembly. First, the routine beginning at line 10200 is called to output the address (the value in F). Then, several routines starting at line 9000 take over to display the hexadecimal machine code, the mnemonic and operands, and the ASCII version of the op code.

The ASCII version of the op code is

Listing continued.

```
2010 GOSUB 10200
2020 GOSUB 9000
2025 PRINT
2030 RETURN
3000 REM ***PRINT A DATA BYTE
3010 GOSUB 10200
3020 B=PEEK(F):GOSUB 10400
3030 POSITION 16,23:PRINT "DATA";
3040 POSITION 30,23:PRINT "' ";CHR$(PEEK(F));"' "
3050 F=F+1:RETURN
9000 REM ***PRINT HEX OPERATION
9010 MN=INT(CD(OP1)/100)
9020 AM=INT(CD(OP1)-100*MN)+1
9030 FOR I=0 TO LN(AM)-1
9040 B=PEEK(F+I)
9050 GOSUB 10400
9060 NEXT I
9070 FOR I=LN(AM) TO 3:PRINT "   ";:NEXT I:PRINT " ";
9085 REM ***PRINT MNEMONIC
9090 B$=A$((MN-1)*3+1)
9100 PRINT B$;" ";
9110 ON AM-1 GOSUB 9200,9650,9250,9300,9350,9400,9450,9500,9200,9200,9550,9600
9120 POSITION 30,23:PRINT "' ";
9130 FOR I=0 TO LN(AM)-1
9140 PRINT CHR$(PEEK(F+I));
9150 NEXT I:PRINT "' ";
9160 F=F+LN(AM):RETURN
9200 REM ***IMMEDIATE,ACCUMULATOR & RELATIVE
9210 B=PEEK(F+1):GOSUB 10400:RETURN
9250 REM ***ZEROPAGE X
9260 GOSUB 9650:PRINT ".X";:RETURN
9300 REM ***ABSOLUTE
9310 B=PEEK(F+2):GOSUB 10400
9320 B=PEEK(F+1):GOSUB 10400
9330 RETURN
9350 REM ***ABSOLUTE X
9360 GOSUB 9300:PRINT ",X";:RETURN
9400 REM ***ABSOLUTE Y
9410 GOSUB 9300:PRINT ",Y";:RETURN
9450 REM ***INDIRECT X
9460 PRINT "(";:GOSUB 9200:PRINT "),X";:RETURN
9500 REM ***INDIRECT Y
9510 PRINT "(";:GOSUB 9200:PRINT "),Y";:RETURN
9550 REM ***INDIR
```

More →

Listing continued.

```
9560 PRINT "(";:GOSUB 9300:PRINT ")";:RETURN
9600 REM ***ZERO PAGE Y
9610 GOSUB 9650:PRINT ",Y";:RETURN
9650 REM ***ZERO PAGE
9660 PRINT "(";:GOSUB 9200:PRINT ")";:RETURN
10000 REM ***HEX TO DECIMAL
10010 H=0:D=0:T=0
10020 FOR I=LEN(H$) TO 1 STEP -1
10030 D$=H$(I)
10040 T=ASC(D$)-48
10050 IF T>9 THEN T=T-7
10060 H=H+T*(16↑D)
10070 D=D+1
10080 NEXT I
10090 RETURN
10100 REM ***SEE IF B IS VALID OP CODE
10110 ISOP=0
10120 FOR OP1=1 TO 151
10130 IF B=OC(OP1) THEN GOTO 10160
10140 NEXT OP1
10150 RETURN
10160 POP :ISOP=1:RETURN
10200 REM ***HEX ADDR. FROM F
10205 P=1:T1=F
10210 FOR D=3 TO 0 STEP -1
10220 FOR E=1 TO 16
10230 IF F-(E*(INT((16↑D)+1)))<0 THEN GOTO 10250
10240 NEXT E
10250 POP :E=E-1:F=F-(E*(INT(16↑D)+1))
10260 E=E+48:IF E>57 THEN E=E+7
10270 H$(P)=CHR$(E)
10280 P=P+1
10290 NEXT D
10300 F=T1
10310 PRINT H$;" ";:RETURN
10400 REM ***CONVERT & PRINT 1 BYTE
10405 B$="":P=1
10410 FOR D=1 TO 0 STEP -1
10420 FOR E=1 TO 16
10430 IF B-(E*(INT((16↑D)+1)))<0 THEN GOTO 10450
10440 NEXT E
10450 POP :E=E-1:B=B-(E*(INT(16↑D)+1))
10460 E=E+48:IF E>57 THEN E=E+7
10470 B$(P)=CHR$(E)
```

More →

displayed because it is quite possible that a piece of data could be interpreted as a legal instruction. For example, the ASCII code for the character X is the same as the op code for the instruction CLD (a hex D8). In some cases, of course, there will be data that is not printable ASCII, but at least with this technique we can catch some of it.

Line 3000 begins the routine to handle data that the program is able to recognize as data (since it has discovered that the byte is *not* a legal op code). Once again the address is displayed, as well as the byte at that location. Then, the word DATA is printed and the ASCII version of that byte is displayed in the appropriate column.

Occasionally, the ASCII version of a byte turns out to be a control code. The result of printing such codes on the screen can sometimes be interesting. I have left out any code to detect such codes but, if the occasional skipped line or tab is offensive, it would be a simple matter to detect and override (perhaps with blanks) their printing.

Now you're ready to go snooping through your Atari's ROMs. If you're not familiar with the 6502, here are a couple of addresses that may interest you (or provide a place to start snooping). Locations FFFC–FFFD (in hex, of course) contain the address to which a 6502 branches when a reset occurs. Locations FFFA–FFFB contain the address that is branched to as a result of a non-maskable interrupt. Locations FFFE–FFFF contain the address that is branched to as a result of a maskable interrupt. With these as a starting point, you should be able to discover quite a lot about how your Atari computer works.

For the sake of standardization, I have used the mnemonics and notation in *6502 Software Gourmet Guide and Cookbook*, except that to make zero page addressing more distinct from immediate mode, I have placed parentheses around zero page operands. Since I'm new to the 6502 and don't yet have the Atari Assembler cartridge, it is possible that the conventions I have chosen are not standard. If anyone is offended by my choice, please accept my apologies. ■

Listing continued.

```
10480 P=P+1
10490 NEXT D:PRINT B$;:RETURN
30000 REM ***MNEMONICS
30005 DATA ADC,AND,ASL,BCC,BCS,BEQ,BIT,BMI,BNE,BPL
30010 DATA BRK,BVC,BVS,CLC,CLD,CLI,CLV,CMP,CPX,CPY
30020 DATA DEC,DEX,DEY,EOR,INC,INX,INY,JMP,JSR,LDA
30030 DATA LDX,LDY,LSR,NOP,ORA,PHA,PHP,PLA,PLP,ROL
30040 DATA ROR,RTI,RTS,SBC,SEC,SED,SEI,STA,STX,STY
30050 DATA TAX,TAY,TSX,TXA,TXS,TYA
30100 REM ***OP CODES,ADDRESSING MODES
30110 DATA 105,101,101,102,117,103,109,104,125,105,121,106,97,107,113,108,41,201
,37,202
30120 DATA 53,202,45,204,61,205,57,206,33,207,49,208,10,309,6,302,22,303,14,304,
40,305
30130 DATA 144,410,176,510,240,610,36,702,44,704,48,810,208,910,16,1010,0,1100,8
0,1210
30140 DATA 112,1310,24,1400,216,1500,88,1600,134,1700,201,1801,197,1802,213,1803
,205,1804,221,1805
30150 DATA 217,1806,193,1307,209,1808,224,1901,228,1902,236,1904,192,2001,196,20
02,204,2004
30160 DATA 198,2102,214,2103,206,2104,222,2105,202,2200,136,2300,73,2401,69,2402
,85,2403
30170 DATA 77,2404,93,2405,89,2406,66,2407,81,2408,230,2502,246,2503,238,2504,25
4,2505
30180 DATA 232,2600,200,2700,76,2804,108,2811,32,2904,169,3001,165,3002,181,3003
,173,3004,189,3005
30190 DATA 185,3006,161,3007,177,3008,162,3101,166,3102,172,3112,174,3104,190,31
06
30200 DATA 160,3201,164,3202,180,3203,172,3204,188,3205,74,3309,70,3302,86,3303,
78,3304
30210 DATA 94,3305,234,3400,9,3501,5,3502,21,3503,13,3504,29,3505,25,3506,1,3507
,17,3508
30220 DATA 72,3600,8,3700,104,3800,40,3900,42,4009,38,4002,54,4003,46,4004,62,40
05,106,4109
30230 DATA 102,4102,118,4103,110,4104,126,4105,64,4200,96,4300,233,4401,229,4402
,245,4403,237,4404
30240 DATA 253,4405,249,4406,225,4407,241,4408,56,4500,248,4600,120,4700,133,480
2,149,4803,141,4804
30250 DATA 157,4805,153,4806,129,4807,145,4808,134,4902,150,4912,142,4904,132,50
02,148,5003,140,5004
30260 DATA 170,5100,168,5200,186,5300,138,5400,154,5500,152,5600
30300 REM ***ADDRESSING MODE LENGTHS
30310 DATA 1,2,2,2,3,3,3,2,2,1,2,3,2
```

With the Cognivox speech input/output peripheral, your computer can understand what you say and answer you back.

The Sorcerer Speaks

By Peter Vernon

The Cognivox VIO-132 from Voicetek, Inc. (PO Box 388, Goleta, CA 93116), is a speech recognition and voice-response peripheral for the Exidy Sorcerer. [*Editor's Note:* Voicetek also manufactures models for AIM-65, Apple II, Commodore PET and CBM, and the TRS-80 computers.] Up to 32 words or short phrases can be entered into the computer's memory and recalled as desired. Any of the stored words can be recognized by the computer and used to control the flow of a program. Music and sound effects can also be reproduced.

The length of Cognivox's voice-response vocabulary depends on the length of the words used and the memory size of your Sorcerer. At least 32K of RAM is required for maximum capability, but the Cognivox can be used with 16K; in this case the response vocabulary will be limited to 12–16 short words, but the word recognition vocabulary will still be 32 words.

From the outside the Cognivox is deceptively simple. It is enclosed in a plastic box measuring 159 mm×96 mm×50 mm, with a 7 cm speaker covered by a mesh grille, a volume control and a socket for a microphone at one end of the box. A dynamic microphone is supplied with the peripheral, along with a cassette of operating and demonstration programs. An 18-page user's manual is also provided, containing a brief description of the operation of the device and further sample programs.

The unit comes fully assembled, ready to plug into the parallel I/O port of the Sorcerer and run immediately.

Before discussing the operation of the Cognivox in more detail, however, let's take a look at the various methods of speech synthesis available for use with small computers.

Speech Synthesis

Three methods can be used to produce speech from a computer. Speaking devices such as those from Texas Instruments use a phoneme synthesis method. Their speech synthesizer chip, used in the Speak & Spell and as a peripheral for the TI 99/4 home computer, is an array of programmable filters, and noise and tone sources. Any desired sound can be reproduced by manipulating the parameters of the filters. This method is also used by the Computalker and the Votrax Type 'n Talk speech synthesizers, although they use discrete components to carry out the same operations as the TI chip.

The main difference between the operation of the TI synthesizer and, for example, the Votrax is that the TI devices contain code for complete words stored in ROM, while the Votrax synthesizer stores codes for the individual phonemes of the English language, allowing words to be built up from combinations of sounds. The Votrax synthesizers are thus more flexible, although much programming effort is needed to use them effectively.

The Computalker is similar to the Votrax devices, although it also provides direct control of nine of the speech parameters in addition to phoneme-based synthesis.

The second method of reproducing speech is digital storage of speech information, using a compression algorithm which eliminates the redundancy of speech information to conserve memory. Data is read out and then expanded to drive a digital-to-analog converter and an amplifier. This is the method used in Digitalker DT1050, the National Semiconductor speech synthesis set. (See "Build a Low Cost Speech-Synthesizer Interface" by Steve Ciarcia in the June, 1981 *Byte* for a board based on this set that can be used with a number of computers.)

The SD200 Supertalker from Mountain Computer also uses a data compression technique. This is the only device besides the Cognivox which offers both speech input and output in one peripheral.

The third possible technique is digital recording, the method used by the Cognivox. Speech signals from a microphone are filtered, and the out-

Peter Vernon, 31 Georgina St., Newtown, NSW 2042, Australia, is a free-lance technical writer and computer systems consultant.

put of the filters is sampled periodically and stored in the computer's memory. Playback is a matter of reading out the digital information and converting it to analog form to drive an amplifier and speaker. Word recognition is performed by comparing the patterns of the input word with the patterns in memory and reporting the closest match.

The advantage of phoneme-driven synthesizers is that, in theory, any word can be reproduced. In practice, however, the intelligibility and quality of the speech suffers unless the synthesizer is carefully programmed by an experienced user. Fixed vocabulary synthesizers store the data for each word in ROM, eliminating the need to program each sound segment of the word individually, but, of course, the vocabulary is limited to the words already coded in the ROM. In some applications this is not a disadvantage, as only a fixed vocabulary is necessary. Telesensory Systems, Inc., has marketed a talking calculator using this approach, and has had considerable success. Both Telesensory Systems and Texas Instruments offer fixed vocabulary synthesizer modules for OEM applications.

Digital recording is the easiest system to use, and has the advantage that the vocabulary can be easily changed. The disadvantage is that the technique uses large amounts of memory to store the speech data. The Cognivox uses a digital sampling technique that sacrifices speech quality for memory storage and ease of use. The sampling rate of about 6 kHz limits the bandwidth of speech to about 3 kHz, creating a degree of distortion similar to speech heard over a telephone. Intelligibility can be quite good if care is taken in entering the words into memory when the vocabulary is first created.

A second advantage of digital recording is that the stored data can be used to identify a word which has previously been entered into memory. The success rate of the recognizer is said to be 98 percent, but in practice seems to be closer to 85 percent. This success rate is dependent on the speaker. You must pronounce each word in the same way each time it is used, and the device will only recognize the voice of the person who trained it.

Using the Cognivox

The Cognivox plugs into the parallel port of the Sorcerer, and takes its power from the computer. The Monitor stack and the BASIC stack must be relocated downwards to create a protected area of memory in which the Cognivox machine-language driver and speech data can be stored. A BASIC program called BOOT is provided on the accompanying cassette to perform this relocation.

The software supplied on the demonstration cassette is recorded at 300 baud for improved reliability. This naturally increases the time taken to load the program, but is not a serious disadvantage. The manual accompanying the Cognivox suggests that you might like to record the programs at 1200 baud to speed loading. (The Sorcerer provides for both baud rates.)

After BOOT has been loaded and run, approximately 4K of RAM remains for application programs. The machine-language driver, VOX2, is not position-independent, and must be loaded into RAM at addresses 1200H to 15FFH. Data tables for this program occupy addresses 1600H to 1CFFH, and speech data is stored from 1D00H to the end of RAM (3FFFH for a 16K Sorcerer, 7FFFH for a 32K machine). [*Editor's Note:* Voicetek has informed us that a relocated version of VOX2 is available starting at 7200H for users with 48K Sorcerers. This version allows more space for user programs and does not conflict with DOS systems.]

All the application programs supplied with the Cognivox will run on a 16K Sorcerer, although a 32K Sorcerer provides more room for the storage of speech data, so that the voice-response vocabulary can be slightly longer and use longer words.

After running BOOT and loading the machine-language driver, your applications programs can be loaded. A demonstration program called PROG2 is provided, and is a good example of the abilities of the system. The program provides six options, covering entry of a vocabulary, playback and recognition. Training the Cognivox requires three passes through the vocabulary. On the first pass the device samples the characteristics of your voice in preparation for the the second pass, which enters the spoken words into memory. The third pass plays back the stored words and asks you to repeat each one into the microphone to fine-tune the system.

The words entered can be played back using option 2 of the demonstration program. I had fun getting my computer to say "Hello, I am a computer. How can I help you?" Each word of a sentence is entered separately, so it requires some practice to achieve a natural-sounding intonation.

Options 4 and 5 exercise the voice recognition abilities of the unit. Option 4 provides recognition with voice response; you say the word, and the computer searches the stored data for a matching pattern and speaks the word it has found. Option 5 is similar, except that rather than speaking the word the computer dis-

Voicetek's speech synthesis unit for the Sorcerer.

plays the number of the word it has found. (Words are numbered in the data area in the order in which they were entered into memory.) Using this program as a guide, it is easy to write BASIC programs which recognize a word and then perform some action on the basis of the word recognized. This is the operating principle of the two demonstration game programs supplied on the cassette.

Since the Cognivox uses a digital recording technique, most of the characteristics of the speaker's voice are retained and reproduced; the unit faithfully reproduces tones of voice, inflections and accents.

Cognivox is useful for more than just games, as another program on the supplied cassette demonstrates. VDUMP is a verbal memory dump. After entering the numbers from zero to nine and the letters from A to F, via the microphone, you can specify an area of memory which will be examined. The program displays addresses and data on the screen for the selected area of RAM, and at the same time the Cognivox speaks the hex value of the byte stored in each memory location. It is also possible to use the routines from PROG2 to reverse the process and have the Cognivox enter data into RAM in response to a spoken message. Entering a machine-language program is then a matter of speaking into the microphone.

Not Just Words

The Cognivox is not restricted to reproducing words. A demonstration program is supplied which illustrates its music and sound-effects capabilities, first with random computer music and then with classical and popular tunes. Several examples of similar programs are given in the operating manual, together with a list of values to produce specific notes of the musical scale. You can control both the frequency and the duration of the sounds.

It is at this point that a limitation of the Cognivox, and of the manual, becomes apparent. To produce middle C the manual suggests that you poke a value of 268 to a location in memory. It is simply not possible to store any number higher than 255 in a single eight-bit byte, and, if an attempt is made to do so on the Sorcerer, a Function Call (FC) error message will be displayed. This means that the lowest note possible for the Cognivox is C sharp above middle C. There may be some way around this problem, but the manual makes no mention of it, and it seems that the author of the manual was unaware that any problem existed.

This is the one fault I found in the system, and is an exception to the generally fine presentation and clarity of the manual.

Other programs supplied on the demonstration cassette are VOTH, a voice-operated version of the game Othello, and VTRAP, a game in which you and the computer maneuver a trace on the display screen to corner the opponent and block any further movement. VOTH uses the word recognition ability of the Cognivox to let the player enter his or her moves verbally, while to play VTRAP you first enter the words "left," "right," "down," "go up" and "faster" and train the Cognivox to recognize them—the player's moving trace on the display then responds to these commands.

The final program supplied is

The guy on the left doesn't stand a chance.

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called CALC, and turns the Sorcerer into a talking calculator. Numbers are announced as they are entered from the keyboard, and are displayed on the screen, together with the arithmetic operation requested. The answer to the problem is also displayed and announced.

Although this demonstration program is limited to four functions and exponentiation, it can be expanded infinitely, to turn your Sorcerer into a talking, programmable scientific calculator with RAM.

The user's manual gives further examples of routines for storing and playing back speech, and for creating music and sound effects. It also provides a circuit diagram for connecting the Cognivox to an external amplifier. The quality of the voice output can be considerably improved with the addition of an amplifier and a larger speaker with a properly constructed baffle.

Opening up the Cognivox voids the 90-day warranty, and reveals the lengths to which Voicetek has gone to protect the secrets of the device. All you will see is a small circuit board, approximately 70 mm×40 mm, entirely covered with a thick blob of epoxy resin. The only information available from Voicetek on the operation of the device is as follows:

The Cognivox represents an excellent value for the money.

"We have reduced the analog preprocessor to a single IC plus a few resistors and capacitors. In addition, our software uses unique learning algorithms that provide superior pattern-matching capabilities. In fact, Cognivox is so novel we are applying for a patent."

The Cognivox works very well—it combines voice response, speech recognition and music and sound-effects generation in one compact unit. You can get good results with a small amount of practice. The combination of all these abilities makes the Cognivox very cost-effective. Instead of separate units for voice output and speech recognition, and another unit for music and sound effects, owners of the Sorcerer can purchase one device, for $149 plus $4 shipping, which fulfills all these functions.

The Cognivox is easier to use than the Computalker or Votrax speech synthesizers, and eliminates the need for a separate speech recognition device. The limitation of the vocabulary size is easily overcome by creating several vocabulary databases and storing them on tape or disk, to be loaded into memory for a particular application, or loaded in response to a spoken keyword. Using this approach, you can make the vocabulary as large as required, divided into blocks of 16 or 32 words.

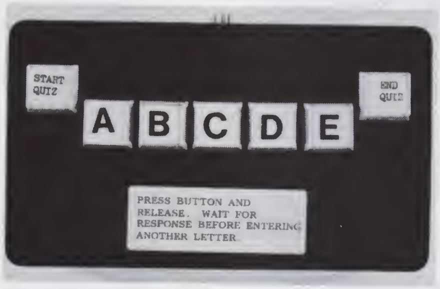
All in all, the Cognivox is an interesting and useful device, and represents an excellent value for the money. If you would like to add a voice and an ear to your Sorcerer, the Cognivox is for you. [*Editor's Note:* Voicetek has recently made hardware improvements to the VIO-132 increasing voice-recognition accuracy. The company has updated and extended the manual (by 25 pages) and increased it to 120 pages.]■

Student-Proof Your Computer

By Ken Reid

A hobbyist's computer is in a protected environment. The user has money invested in his system, and takes precautions to avoid such expensive mistakes as spilling Pepsi on his keyboard.

But schools are different. If a fragile input device is left unsupervised, it won't be functioning for long. Software, too, is vulnerable; it takes only one clever or malicious student who knows how your system works to produce startling changes in your carefully constructed educational program.



The input keybox.

Experiences of this type were uppermost in our minds when we developed a classroom-sized (24 work stations) input system for a microprocessor-controlled CAI system for our Health Sciences Library at the University of Louisville. Our student access terminals had to be foolproof. So we developed an input keybox.

Why use special input keyboards? First, the signals enter your program and cannot be used for anything else. This restriction is an absolute necessity for any system which is intended for, or exposed to, unrestricted public access. The operator's console is separate and can be kept safely behind locked doors.

Second, the user is less likely to be confused if his options are restricted. Few CAI programs require more than four or five options at each choice point.

Third, simple keyboards cost less than complex ones, both in dollars and maintenance.

The box is made of heavy black plastic. The key assembly and circuitry is mounted on the cover for easy construction, and the cover is attached to the box by four nylon machine screws. These are sealed after assembly with plastic cement. The seven keys are Hall-effect switches (Microswitch PK 8913-3), which we obtained as a surplus lot from NCE Compumart. We used blank keycaps and inserted our special labels.

The keybox circuit is shown in Fig. 1. Each box provides a one-bit "I'm here" signal as long as it is connected and another three bits indicating which key has been pressed. Once a key has been pressed the output locks; further keypresses have no effect until the computer reads the signal and returns a reset pulse. Two four-bit keyboxes share one eight-bit parallel port, 12 ports for our 24 stations. At present we are using three Imsai 4PIO boards to provide these.

Our 24-keyboard installation has been in service for over a year. During this period we have had two boxes quit due to off-voltage regulators. We have had no key failures.

Numerous keycaps—at least 40 so far—have been cracked, due to excessive force. We find that "keybeating" occurs (a) when the system is heavily loaded and response is slow or (b) when the system has malfunctioned. This "kick the machine" attitude must be acknowledged by any system designer whose machinery is open to unsupervised use by the general public. Be prepared! ■

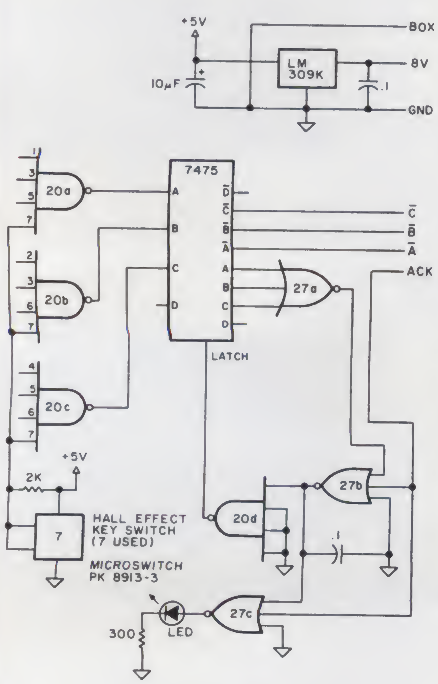


Fig. 1. Keybox circuit.

Ken Reid, 1935 Trevilian Way, Louisville, KY 40205

What's the Difference?

By R. B. Nottingham

While rereading the November 1980 issue of *Microcomputing*, my attention was drawn to the wind chill temperature program in Robert Baker's PET-pourri column (p. 14). Suddenly, the antennae of my memory began to quiver. I looked closely at the data, and it was familiar. I had seen it before. Here it was again and still *wrong*!

How was I able to recognize the data, tell that it was wrong by inspection, correct it and then amplify it? Mathematicians refer to the method as difference calculus or the method of finite differences. Don't let the reference to calculus throw you. You can use difference methods if you can add and subtract, or tell your microcomputer to.

I have never seen the topic mentioned in the recent *Microcomputing* literature, and I think it is too good a tool not to have in your bag of tricks. So I'll briefly discuss difference methods and then apply them to the problem mentioned above.

Back to Babbage

About 120 years ago, Charles Babbage conceived the stored program computer with hard-copy output. He called his device a difference, or analytical, engine. He was concerned with the problem of producing errorless tables of functions for use in navigation at sea. He had realized that the only way to produce error-free tables was to produce them automatically, without human intervention.

Babbage realized that you could generate any continuous function over an interval by simply adding differences. If you look at the squares of the integers 1, 4, 9, 16, 25, and at their first differences, 3, 5, 7, 9, you'll see that their second differences are a constant 2. So you can generate a table of squares by successively adding 2 and then successively adding these numbers.

Now try it with cubes. Yes, there is a theorem that in a series of this type,

```
1 REM DIFFERENCE CALCULUS APPLIED TO WIND-CHILL DATA
2 REM R. B. NOTTINGHAM, 10-31-80
60 DIM C(8,11)
70 FOR W = 0   TO 8: FOR T = 0 TO 11
80 READ C(W,T):NEXT T: NEXT W
90 DATA -60,-50,-40,-30,-20,-10,0,10,20,30,40,50
100 DATA -68,-57,-47,-36,-26,-15,-5,6,16,27,37,48
110 DATA -95,-83,-70,-58,-46,-33,-21,-9,4,16,28,40
120 DATA -112,-99,-85,-72,-58,-45,-36,-18,-5,11,22,36
130 DATA -124,-110,-96,-82,-67,-53,-39,-25,-10,3,18,32
140 DATA -133,-118,-104,-88,-74,-59,-44,-29,-15,0,13,30
150 DATA -140,-125,-109,-94,-79,-63,-48,-33,-18,-2,13,28
160 DATA -145,-129,-113,-98,-82,-67,-49,-35,-20,-4,11,27
170 DATA -148,-132,-116,-100,-85,-69,-53,-37,-21,-6,10,26
185 GOTO 1000
1000 FOR W=1 TO 8
1010 FOR T= 1 TO 11
1020   PRINT"C(";W;",";T;")= ";
1030   PRINTC(W,T),
1040   IF T=11 THEN GOTO 1110
1050   D1(T)=C(W,T)-C(W,(T+1))
1060   IF T=0 OR T>9 THEN GOTO 1070
1070   PRINTD1(T)
1080   IF T<2 OR T>9 THEN GOTO 1110
1090   D2=D1(T)-D1(T-1)
1100   PRINT TAB(20)D2
1110 NEXT T
1120 PRINT
1130 INPUT"pRESS ENTER TO CONTINUE";QQ
1140 NEXT W
1150 FOR T=0 TO 11
1160 FOR W=1 TO 8
1170   PRINT"C(";W;",";T;")= ";
1180   PRINTC(W,T);
1190   IF W=8 THEN GOTO 1250
1200   D1(W)=C(W,T)-C(W+1,T)
1210   PRINTD1(W)
1220   IF W<2 OR W>6 THEN GOTO 1250
1230   D2=D1(W)-D1(W-1)
1240   PRINTTAB(20)D2
1250 NEXT W
1260 PRINT
1270 INPUT"PRESS ENTER TO CONTINUE",
1280 NEXT T
1290 END
```

Program listing.

Address correspondence to R. B. Nottingham, 1619 SE 3rd Court, Deerfield Beach, FL 33441.

the difference which becomes constant is the power of the series. Squares, second difference; cubes, third difference, and so on.

This is a useful tool. If you have a function—the flight of a model rocket, the landing path of an airplane or whatever—that you want to show on your computer, it may make much better sense to store the equation of the curve and calculate it as you need it, rather than store all the data of the curve itself. If you examine the successive differences in the data, and you find that some difference tends to become a constant, that gives the order of the polynomial that will be needed to fit the data.

Wind Chill

Now regarding wind chill. I had found an article on the subject several years ago in a bicycling magazine, giving the same data which Baker used. If you do not have his program handy, lines 60–170 in Listing 1 are copied directly from it. The data in line 90 represents Fahrenheit temperatures from −60 to +50.

The lower temperatures are a little exotic unless you plan to wing-walk at high altitudes or visit the poles. Plus 50 was not quite high enough to suit me. It is rarely that cold in south Florida, and believe it or not, when one is acclimated here, riding a bike with the temperature in the 60s can feel chilly, particularly if the sun isn't shining. So I decided to extend the table up to 70 or 80 degrees, perhaps discarding the very low temperatures.

Line 100 gives the wind chill for a five mph wind, and successive lines increase the speed in increments of five mph. Comparing line 90 and line 100, from right to left, you see that the wind chill increases as the air temperature gets lower. Reasonable enough. If you read down any column, you'll see that the increase in wind chill gets less as the wind speed increases. The increases from 35 mph to 40 mph (lines 160, 170) are very small. Apparently, once the wind speed is high enough to carry away all our body heat, more wind doesn't make much difference.

Now, if you look at the differences along any line, the wind chill seems to increase about 10 or 15 degrees for every ten-degree change in temperature. But look at the right end of line 120. The differences are 14, 11, 16, 13, etc. There is no way that the differences can jump around like this. As our German friends don't say, "Etwas ist gestunken."

Apparently, the wrong table has been copied and copied with no reference to the original. Errors have crept in and have propagated. So what do we do about it?

Since you have a microcomputer, you might as well put it to work. If you have the Baker Wind-Chill program loaded, just add line 185 from Listing 1, and lines 1000–1160. Do not add line 2120. It is simply my approximately corrected version of line 120. You may well be able to do better.

Now run the program; you will see the original data and the first and second differences, first along the rows, and then down the columns. Obviously there is trouble. What you want to do is make the differences uniform. When you find a difference you don't like, press the break key.

Then, in the direct mode, enter C(W,T)=X, replacing W,T and X with the appropriate values. Type GOTO 1000. Do not type RUN or the variables will be set to zero. Repeat this until the differences please you and then correct the DATA statements. If you have a printer, you may, of course, LLIST the array for your new data.

If you wish to extrapolate the table to higher temperatures, this is easy to do, if you watch the differences. For example, at five mph, it looks like the difference at 60 degrees will be either one or two degrees, and at 70, one degree.

At 40 mph, the difference is running about 16 degrees, so you might make the wind-chill temperature for 60, 42 degrees, and for 70, about 67 degrees. If you keep the differences smooth you won't be far off, even though extrapolation (going out beyond the original data) is always dangerous. A function may be discontinuous, but I would be very surprised if wind chill were. If you add temperatures to each data line, be sure to either delete temperatures at the left of the line, or revise the dimensions of the arrays.

Have fun. I think that the method of differences is a useful tool, and just thinking in terms of differences can often let you spot bad data. ■

✓See List of Advertisers on page 194

TSC Extended BASIC

By Phil Hughes

TSC Extended BASIC (Technical Systems Consultants, PO Box 2570, W. Lafayette, IN 47906) is an excellent product for the 6800 and 6809 microprocessors. It has the abilities of a comprehensive BASIC, is well-documented and relatively bug-free. If you are running Flex and need a BASIC with these capabilities, it is well worth its price. It costs $100, configured for either five- or eight-inch disks.

In spite of the comprehensive additions, TSC Extended BASIC is fast. Table 1 shows comparison times for the fastest BASIC (OSI), Altair extended BASIC and the other two 6800 BASICs. These times are for running Tom Rugg's and Phil Feldman's benchmark programs that appeared in the June 1977 issue of *Kilobaud* ("BASIC Timing Comparisons," p. 66).

Note that OSI BASIC was run on a system that could not support disk drives because the clock speed was doubled. The first TSC Extended BASIC test ran with the benchmarks exactly as written. The second line shows timing information when the control variables in the FOR-NEXT loops were changed to integer data type.

Extensions

Now that you know that this BASIC is competitive in speed, let's look at the extensions in detail. First consider the extensions to variables and operators. Variable names have been extended to allow two alphabetic characters, as well as the standard alphabetic and alphabetic followed by a numeric. For example, AB is a valid variable name, as are A and A1. This is important because it is easier to imagine that ST stands for subtotal than S or S7.

Note that there are seven two-letter combinations that are keywords and therefore cannot be used as variable names. They are AS, FN, IF, ON, OR, PI and TO.

The other big addition to variables is the integer data type. These variables may be mixed with floating point (real) variables, and will save both execution time and storage space. They are particularly useful for loop control variables and array subscripts.

Their range is from −32768 to 32767 and they take only two bytes of storage. Compare this with eight bytes for a floating point variable. An integer variable is identified by the suffix %. For example,

```
FOR I% = 1 TO 100:NEXT I%
```

is a loop with the integer control variable I%.

New operators consist of the logical operators AND, OR and NOT and the string concatenation operator, +. The logical operators operate on integers in a bit-by-bit fashion. If the arguments of a logical operator are real variables, they are automatically converted to integers before the operation is performed. Also, if the real variables have too large a value for conversion, an error message is printed.

The next group of new features, statement extensions, is added to existing BASIC statements. The first of these is an addition to the RESTORE statement which lets you specify the statement number to which the data pointer should be reset. This would have saved me some time when I converted WUMPUS 2 to run on the SWTP system in 1977.

Next, and definitely more important, is the addition of the ELSE clause to the IF statement. In a sentence, this allows you to write a statement with the form

```
IF condition THEN do this ELSE do something else
```

INPUT LINE lets you read an entire line of input, including spaces, punctuation and quotes, into a single string variable. *This is very useful* when you are trying to make programs easy for the naive user. PRINT USING is a very important feature for business programming. This statement lets you format your output as you wish, overriding the automatic zoning of BASIC.

Although it's hard to think of PEEK

Phil Hughes (PO Box 2847, Olympia, WA 98507) owns Specialized Systems Consultants, a computer hardware/software consulting company.

Hardware/Software	CPU	1	2	3	4	5	6	7
1. OSI 8K BASIC @ 2MHz	6502	.9	4.6	8.2	9.3	10.0	14.8	21.6
10. Altair Disk Extended BASIC	8080	1.9	7.5	20.6	20.9	22.1	36.9	58.5
28. Southwest Tech 8K BASIC 1.0	6800	14.9	24.7	96.1	105.3	109.8	174.1	204.5
*** TSC Extended BASIC	6800	1.2	4.4	19	21.5	22	29	38.5
*** TSC Extended BASIC w/integer control variables	6800	.4	2.9	7.5	7.5	8	12	20.5

Table 1. Comparison times for standard and extended BASICs.

and POKE as extensions anymore, they are included. With the capability of the HEX function (see functions) they are somewhat more usable.

Two new statements that seem to fit into this same group are DIGITS and SWAP. The DIGITS statement specifies the maximum number of digits that are to be printed in an answer. This is independent of PRINT USING. DIGITS is useful for those of us with a background in mathematics who know how absurd it is to tell someone that the average of 13, 55, 97, 87, 66, 90, 94, 64 and 45 is about 67.888888888888891.

SWAP is useful for speeding up sorts. It switches the values of two variables in one step. It is particularly useful with string variables, where it changes the contents of two four-byte string descriptors rather than moving the actual data strings.

The next category of extensions is functions. The standard mathematical functions exist with 16-digit accuracy for LOG, EXP and SQR, and 13-1/2-digit accuracy for ATN, COS, SIN and TAN. There is also a full set of string-to-integer, integer-to-string and substring handling functions.

The substring function least likely to exist in other BASICs is INSTR, the equivalent of the PL/1 function, INDEX. This function will search a specified string, starting at a given position, and return the location of a specified substring. This function, along with INPUT LINE, makes an excellent tool for fancy input handling routines.

Another important function is HEX, which converts a string of up to four characters into an integer with an equivalent value. For example, you can write HEX ("8000") instead of 32768.

System Interface Extensions

The system interface extensions exist at the command level of BASIC, and let you communicate with the operating system. Note that some of these capabilities may also be used within statements. The standard ones are RUN, LIST, CONT, LOAD, SAVE and NEW. TSC Extended BASIC offers a whole lot more.

The first one is COMPILE. This lets you save a BASIC program on disk in a compiled form. In this form the program uses less disk space, and therefore will load faster than its source. At execution time a source or compiled program will run at essentially the same speed. Also, a compiled program cannot be listed or edited. This gives you a method of releasing executable programs to others without making the source available.

TRON and TROFF allow you to turn on and off the line number trace. This is not very useful, since you cannot embed TRON and TROFF statements in your program and therefore must trace everything. SCALE allows you to force the roundoff of floating point numbers. In early BASICs, it was quite common to get .999999 as the result of dividing 10 by 10. This BASIC takes care of its own roundoff problems, but SCALE is there if you have a special case. One special case is, of course, rounding off dollars and cents to even pennies.

RENUMBER is actually a program that is loaded into the utility command space of Flex. It comes with BASIC, works very fast and renumbers lines in the currently loaded BASIC program. It's about time BASIC came with this important feature.

KILL and RENAME allow you to delete and rename disk files. Both of these commands can also appear in statements. This lets you handle file maintenance within the BASIC program. CHAIN, another system interface command that can appear in a program statement, allows you to load and start execution of a new program. CHAIN also lets you specify the line number where execution is to begin.

In addition to these specific BASIC commands, any Flex command that

loads into the utility command space can be executed by preceding its name with a plus sign (+). Through this method CAT (catalog list), TTYSET (configure terminal characteristics) and many other commands can be accessed. The BASIC statement EXEC permits access from within a program. Don't try +NEWDISK; although it loads into the UCS, it appears to use low memory for an I/O buffer, and you never hear from BASIC (or anything else until you push RESET) once you start it.

Advanced Disk Capabilities

TSC devotes 14 pages of the user's manual to advanced disk capabilities, but even with this much information you may spend a lot of time rereading and testing to get the hang of it. I can only let you know the capabilities are there—plan to spend some time getting to know how to use them.

All of these capabilities have to do with random access disk files. The first one, virtual arrays, consists of an array (dimensioned variable) stored in a disk file instead of RAM. It can be used just like any other array, with a few exceptions. A reference to an element of the array causes an automatic read from, or write to, disk. The reference is considerably slower than if the element had been in RAM, but much larger arrays can be handled.

Now the exceptions. All elements of a string virtual array must be the same length. The maximum length of a string element in a virtual array is 252 bytes (*vs* 32767 for ordinary string arrays). The third exception is that values in a virtual array cannot be displayed using PRINT if a program has terminated in error. Although, initially, this third exception seems like a severe handicap in debugging, it can be sidestepped by using the ON ERROR and STOP statements.

The second type of random I/O is Record I/O, which allows you to read or write any sector within a disk file. These sectors correspond to physical disk sectors, which consist of 252 data bytes and four Flex header bytes. A read is performed by the GET statement, and a write is performed by the PUT statement. This is the basis for Record I/O; everything else is just a set of tools to make it easier to use.

The first tool is the FIELD statement. FIELD allows you to assign string variable names to parts of the 252-byte buffer which is used by GET and PUT. Two other tools, LSET and RSET, allow you to store data in the portions of the buffer described by the FIELD statements. The four tools completing the available set are conversion routines which convert integers and floating point numbers to and from strings. These are necessary because Record I/O files contain only characters.

Using these tools, you can describe records consisting of specified fields of data, and read and write these records. If these records are 252 bytes in length, then a record is a sector and everything goes smoothly.

To handle records less than 252 bytes, you must either waste disk space or pack multiple records into a single sector. Packing can be done with the FIELD statement, but it takes a lot of the pleasure out of having this type of I/O. In a sentence, it isn't elegant but it does the job.

Now that you know what Record I/O is, you can see that it makes doing inventory systems and the like feasible. Using Record I/O for data files and virtual arrays for indexes, you will find that inverted key (look up by more than one thing) file access systems become practical. For example, you can look up an entry in an address list by either last name or ZIP code.

Some Problems

Bug-wise, the version that I have (version 8) is a very stable product. This is the third version that I have had, but TSC was very cooperative in sending updated versions in response to my documented problems. The only remaining problem that I find irritating is that certain errors in a program cause the LOAD command to terminate without loading the entire file. Actually, the irritating part is that no error message is issued. This only occurs on files which have been created by the editor or another BASIC. TSC Extended BASIC will not allow you to enter lines that cause this error.

I have two other complaints. First, extended BASIC is very big—a little over 18K. For the features available, the size is not excessive, but you may have to justify the cost of that new 16K memory board along with the cost of BASIC. And the documentation on extended BASIC, like most other TSC documentation, is hard to use. I don't know why this is, but my customers have the same problem. All of the information is in the manual—it's just hard to find.■

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This TRS-80 program helps you get the most out of your resources.

How to Maximize Profits

By James R. Burns

A dentist is faced with deciding how best to split his practice between the two services he offers—general dentistry and pedodontics (children's dental care). Given his resources, how much of each service should he provide to maximize his profits?

He can find the answer with the help of a process known as mathematical programming (MP). This is not programming in the computer sense of the word, but instead refers to a specific set of mathematical procedures used to solve a problem.

Every mathematical programming problem consists of a goal and a set of constraints. For the business manager, the goal is to find a product mix that will realize the greatest net return. The constraint is that the resources he can allocate to his products or services are limited. These resources might include money, manhours, machine capacities or warehouse space.

Since the computer can do the computational work, a manager need not be a mathematician to use MP successfully. What he must be able to do, however, is 1) recognize when MP is an appropriate method to use, 2) formulate the problem so that it can be solved (by the computer) and 3) interpret the results and use them correctly.

A Resource Allocation Problem

The dentist mentioned above employs three assistants and uses two operatories (work stations). Each pedodontic service requires .75 hours of operatory time, 1.5 hours of an assistant's time and .25 hours of the dentist's time. A general dentistry service requires .75 hours of an operatory, 1 hour of an assistant's time and .5 hours of the dentist's time. Net profit for each service is $10 for each pedodontic service and $7.50 for each general dental service. Since the dentist's office is open eight hours a day, there are eight hours of dentist's time each day, 16 hours of operatory time, and

Listing 1. Mathematical programming in TRS-80 Level II BASIC.

```
10 CLS:CLEAR500:PRINTSTRING$(63,191):PRINT@83,"MAXIMIZE YOUR PROFITS":PRINTSTRIN
G$(63,149)
20 PRINTTAB(23)"JAMES R. BURNS"
30 PRINTTAB(15)"SOFTWARE ENGINEERING SYSTEMS, INC."
40 PRINTTAB(22)"3204 80TH STREET"
50 PRINTTAB(21)"LUBBOCK, TEXAS 79423"
60 FORI%=1TO20:PRINT@448,STRING$(63,191):PRINT@448,STRING$(63,149):NEXTI%
70 '
80   ENTER NUMBER OF VARIABLES AND NUMBER OF CONSTRAINTS
90 '
100 INPUT"WHAT IS THE NUMBER OF PRIMAL VARIABLES";N%
110 INPUT"WHAT IS THE NUMBER OF CONSTRAINTS";M%
120 E%=1:L%=M%+E%:K%=N%+L%
130 DIMTA(L%,K%),RA(M%)
140 '
150 ' DEFINE CONSTRAINT COEFFICIENTS
160 '
170 FORI%=E%TOM%
180 FORJ%=E%TON%
190 PRINT"COEFFICIENT OF VARIABLE";J%;"IN CONSTRAINT";I%;
200 INPUT"IS";TA(I%,J%):NEXTJ%
210 PRINT"AMOUNT OF RESOURCES IN CONSTRAINT";I%;
220 INPUT" IS";TA(I%,K%):TA(I%,N%+I%)=E%:NEXTI%
230 '
240 ' DEFINE OBJECTIVE FUNCTION COEFFICIENTS
250 '
260 FORJ%=E%TON%
270 PRINT"WHAT IS THE COEFFICIENT ASSOCIATED WITH VARIABLE";J%;" IN THE"
280 INPUT"OBJECTIVE FUNCTION";TA(L%,J%)
290 TA(L%,J%)=-TA(L%,J%):NEXTJ%
300 INPUT"DO YOU WISH THE TABLEAU PRINTED AFTER EVERY ITERATION--Y/N";T$
310 '
320 ' BEGIN SIMPLEX ITERATIONS HERE
330 '
340 ' PICK THAT COLUMN WITH THE MOST NEGATIVE "INDICATOR" AS THE NEXT
350 ' VARIABLE TO ENTER THE BASIS.  START WITH ONLY SLACK
360 ' VARIABLES IN THE INITIAL BASIS.
370 '
380 GOSUB990
390 MI=1E30
400 FORQ%=E%TON%+M%
410 IFMI<=TA(L%,Q%)THEN440
420 MI=TA(L%,Q%)
430 J%=Q%
440 NEXTQ%
450 IFMI>=0THEN820
460 '
470 ' A COLUMN (J%) WITH THE MOST NEGATIVE INDICATOR HAS BEEN FOUND
480 '
490 FORI%=E%TOM%
500 '
510 ' FIND THE ROW WHOSE RATIO IS SMALLEST POSITIVE. ASSOCIATED
520 'VARIABLE IS EXITING BASIS VARIABLE.
530 '
```

James R. Burns (3204 80th St., Lubbock, TX 79423) is an associate professor at Texas Tech University and president of Software Engineering Systems, Inc.

24 hours of assistants' time each day.

The objective is to divide each eight-hour day between general practice and pedodontics in such a way as to maximize profit. Let x_1 represent the number of pedodontic patients seen per day and x_2 the general dentistry patients seen per day. Then the objective function for this problem is expressed by $10x_1 + 7.5x_2$.

Formulating an MP problem begins with an identification of the resources and the products or services.

The constraints are the total hours available for each of the three resource categories—dentist's time, operatory time and assistants' time. Eight hours are available to the dentist. Each pedodontic service requires (as stated) .25 hours of the dentist's time, and each general practice, .5 hours. The total time devoted to these two categories is $.25x_1 + .5x_2$. Since this must be less than or equal to eight, the constraint is written

$.25x_1 + .5x_2 \leq 8$ (dentist's time)

The remaining two constraints are written

$1.5x_1 + x_2 \leq 24$ (assistants' time)

$.75x_1 + .75x_2 \leq 16$ (operatory time).

In total the problem as formulated is

maximize $10x_1 + 7.5x_2$

subject to

$.25x_1 + .5x_2 \leq 8$ dentist

$1.5x_1 + x_2 \leq 24$ assistants

$.75x_1 + .75x_2 \leq 16$ operatories.

How to Formulate an MP Problem

As the example above shows, the task of formulating an MP problem begins with an identification of the resources and the products or services. For each product or service, a variable x_i is defined. Then the objective is written in the language of mathematics as a statement of the profit potential for a given time period. Each x_i variable is multiplied by the net profit accruing from the sale of just one unit of the product or service.

In the problem above, $10 of profit is realized from each pedodontic (patient) service. If five such services were provided in any given day, then $50 of profit would accrue from pedodontic services alone. Similar statements could be made about general dentistry services. Hence, total profit is the sum of the individual profits arising from the provision of these two services.

Once the objective is formulated, the constraints are written. Each constraint expresses the resource requirements for a particular product mix. The total resource requirement must be less than or equal to the total amount of resource available for a particular resource. Mathematically, this is written as an inequality. In the problem posed above, there are three resources, and therefore three inequalities. In addition to these inequalities, the x_i variables must be non-negative. (A negative value for x_1, the number of hours devoted to pedodontic services, has no meaning; similarly for x_2.)

```
540 IFTA(I%,J%)<1E-10THENRA(I%)=1E35:GOTO560
550 RA(I%)=TA(I%,K%)/TA(I%,J%)
560 NEXTI%
570 MI=1E35:IN%=100
580 FORI%=E%TOM%
590 IFRA(I%)>=MIORRA(I%)<=0THEN610
600 MI=RA(I%):IN%=I%
610 NEXTI%
620 IFIN%=100THENPRINT"SOLUTION UNBOUNDED":END
630 DI=TA(IN%,J%)
640 FORI%=E%TOK%
650 TA(IN%,I%)=TA(IN%,I%)/DI
660 NEXTI%
670 FORA%=E%TOL%
680 IFA%=IN%THEN760
690 '
700 ' BEGIN PIVOT HERE
710 '
720 MU=TA(A%,J%)
730 FORI%=E%TOK%
740 TA(A%,I%)=TA(A%,I%)-MU*TA(IN%,I%)
750 NEXTI%
760 NEXTA%:GOSUB990
770 GOTO390
780 '
790 ' SOLUTION HAS BEEN FOUND AS THERE ARE NO COLUMNS WITH NEGATIVE
800 ' INDICATORS.  RESULTS ARE PRINTED IN THE STATEMENTS THAT FOLLOW.
810 '
820 CLS:PRINT"MAXIMUM OBJECTIVE FUNCTION VALUE IS":TA(L%,K%)
830 FORJ%=E%TON%
840 IFTA(L%,J%)>0.THEN880
850 FORI%=E%TOM%
860 IF.999<TA(I%,J%)ANDTA(I%,J%)<1.001THENPRINT"MAXIMUM VALUE FOR VARIABLE";J%;"
IS";TA(I%,K%):GOTO880
870 NEXTI%
880 NEXTJ%
890 INPUT"HIT ENTER TO SEE SHADOW PRICES--OK";XX
900 CLS:PRINT"SENSITIVITY COEFFICIENTS (DUAL VARIABLES) ARE"
910 FORI%=E%TOM%
920 PRINTTAB(20)TA(L%,N%+I%)
930 NEXTI%
940 INPUT"HIT ENTER TO END";XX
950 END
960 '
970 ' ROUTINE TO PRINT SIMPLEX TABLEAU
980 '
990 IFT$<>"Y"THENRETURN
1000 FORU%=E%TOL%
1010 PRINT"ROW";U%;STRING$(1,170);
1020 FORV%=E%TOK%
1030 PRINTTA(U%,V%);
1040 NEXTV%
1050 PRINT
1060 NEXTU%
1070 INPUT"HIT ENTER TO RETURN--OK";XX
1080 RETURN
```

How to Use the Computer Program

The computer program shown in Listing 1 can be used to solve this problem. As listed, the program is ready to run on a TRS-80 Level II machine. Some modification may be required for other machines. The program uses the simplex method of solution and is able to detect when the problem is unbounded. Appropriate responses to the queries posed by the program for the problem described above are shown in Sample 1a.

User responses appear to the right of each query (which ends with a question mark). The queries request the number of variables and constraints, followed by all coefficients in the constraints and in the objective function. Array dimensions and slack variables are taken care of automatically by the program and do not require user attention. To properly enter responses to the queries you must define (for yourself) the variables, ob-

```
WHAT IS THE NUMBER OF PRIMAL VARIABLES?  2
WHAT IS THE NUMBER OF CONSTRAINTS?  3
COEFFICIENT OF VARIABLE 1 IN CONSTRAINT 1?  .25
COEFFICIENT OF VARIABLE 2 IN CONSTRAINT 1?  .5
AMOUNT OF RESOURCES IN CONSTRAINT 1?  8
COEFFICIENT OF VARIABLE 1 IN CONSTRAINT 2?  1.5
COEFFICIENT OF VARIABLE 2 IN CONSTRAINT 2?  1
AMOUNT OF RESOURCES IN CONSTRAINT 2?  24
COEFFICIENT OF VARIABLE 1 IN CONSTRAINT 3?  .75
COEFFICIENT OF VARIABLE 2 IN CONSTRAINT 3?  .75
AMOUNT OF RESOURCES IN CONSTRAINT 3?  16
WHAT IS THE COEFFICIENT ASSOCIATED WITH VARIABLE 1 IN THE OBJECTIVE
FUNCTION?  10
WHAT IS THE COEFFICIENT ASSOCIATED WITH VARIABLE 2 IN THE OBJECTIVE
FUNCTION?  7.5
DO YOU WISH THE TABLEAU PRINTED AFTER EVERY ITERATION—Y/N?  N
```

Sample 1a.

```
OPTIMUM ANSWER IS 170
MAXIMUM VALUE FOR VARIABLE 1 IS 8
MAXIMUM VALUE FOR VARIABLE 2 IS 12
HIT ENTER TO SEE SHADOW PRICES—OK?
SENSITIVITY COEFFICIENTS (DUAL VARIABLES) ARE
    2.5
    6.25
    0
HIT ENTER TO END?
```

Sample 1b.

jective function, constraints and coefficients that are needed in the MP model. From the responses entered in Sample 1a it should be clear that the following conventions were used:

- variable 1—x_1, pedodontic patients seen per day
- variable 2—x_2, general dentistry patients seen per day
- constraint 1—dentist's time per day
- constraint 2—assistants' time per day
- constraint 3—operatory time per day.

Once computations required by the simplex algorithm are complete, the reports in Sample 1b are printed.

Clearly the optimum (maximum) objective function value is $170 daily. The dentist should see eight pedodontic patients per day and 12 general dentistry patients per day. In addition to the above reports the program will also print the simplex tableau after each iteration if you respond with "Y" to the last query in the sequence. It is easy to verify that when (8, 12) replaces (x_1, x_2) in the objective function, a value of 170 is realized—i.e., $10 \times 8 + 7.5 \times 12 = 170$. Also, it is easy to verify that all of the dentist's time per day and all of the assistants' time per day are used up by the combination (8,12).

Sensitivity Studies

The sensitivity coefficients indicated in Sample 1b tell how sensitive the optimum answer (objective function value) is to changes in the resource value associated with each constraint. Thus, the resource associated with constraint 1 (dentist's time) has a sensitivity value of 2.5, the resource associated with constraint 2 (assistants' time) has a sensitivity value of 6.25, and so on. Since there are three constraints in the problem, three sensitivity coefficients are printed.

Obviously, the answer is most sensitive to changes in the assistants' time resource. In fact, one unit of increase in this resource will produce 6.25 additional units of profit in the objective function. Our hypothetical dentist would be well-advised to add extra hours of dental assistants' time per day; it is the resource that should be increased first.

A Portfolio Selection Problem

Resource allocation problems are not the only MP problems solvable by the program in Listing 1. The program can also be used to solve portfolio-selection problems, as typified by the following.

A stockbroker has been asked by a client to invest a sizeable sum of money in a portfolio of common stocks. The overall objective is to maximize the growth of capital. However, the portfolio is not to exceed a prescribed degree of risk. Also, the portfolio must provide at least enough income to pay for taxes and other expenses.

The stockbroker has available to him information on a large number of companies, broken down into various industry groups. Each company is rated on a scale of 0 to 9 for its growth and risk potential, where 0 indicates no growth or no risk and 9 indicates highest growth or highest risk. No more than 35 percent of the portfolio is to be invested in any one industry group. The risk factor cannot exceed 10. The information about the companies is given in Table 1.

Let x_i represent the fraction of the portfolio to be invested in company i. Then the MP problem can be formulated in accordance with the remarks made above as follows:

maximize $7x_1 + 2x_2 + 8x_3 + 9x_4 + 3x_5 + 6x_6 + 7x_7 + 8x_8 + 6x_9 + 4x_{10} + 3x_{11} + 4x_{12} + 8x_{13} + 8x_{14} + 8x_{15} + 9x_{16}$

subject to

$3x_1 + 6x_2 + 5x_3 + 8x_4 + x_5 + 5x_6 + 7x_7 + 2x_8 + x_9 + 4x_{10} + 5x_{11} + 6x_{12} + 9x_{13} + 7x_{14} + 8x_{15} + 7x_{16} \leqslant 10$

$x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 + x_8 + x_9 + x_{10} + x_{11} + x_{12} + x_{13} + x_{14} + x_{15} + x_{16} \leqslant 1$

$x_1 + x_2 + x_3 + x_4 \leqslant .35$

$x_5 + x_6 + x_7 + x_8 \leqslant .35$

$x_9 + x_{10} + x_{11} + x_{12} \leqslant .35$

$x_{13} + x_{14} + x_{15} + x_{16} \leqslant .35$

In all, this problem has 16 variables and six constraints. The first constraint relates to risk. The second

Industry	A				B				C				D			
Company	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Growth	7	2	8	9	3	6	7	8	6	4	3	4	8	8	8	9
Risk	3	6	5	8	1	3	7	2	1	4	5	6	9	7	8	7

Table 1.

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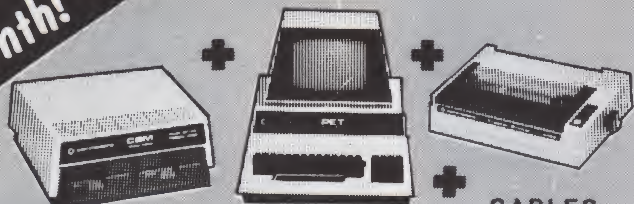

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```
WHAT IS THE NUMBER OF PRIMAL VARIABLES? 16
WHAT IS THE NUMBER OF CONSTRAINTS? 6
COEFFICIENT OF VARIABLE 1 IN CONSTRAINT 1 IS? 3
COEFFICIENT OF VARIABLE 2 IN CONSTRAINT 1 IS? 6
COEFFICIENT OF VARIABLE 3 IN CONSTRAINT 1 IS? 5
COEFFICIENT OF VARIABLE 4 IN CONSTRAINT 1 IS? 8
COEFFICIENT OF VARIABLE 5 IN CONSTRAINT 1 IS? 1
COEFFICIENT OF VARIABLE 6 IN CONSTRAINT 1 IS? 5
COEFFICIENT OF VARIABLE 7 IN CONSTRAINT 1 IS? 7
COEFFICIENT OF VARIABLE 8 IN CONSTRAINT 1 IS? 2
COEFFICIENT OF VARIABLE 9 IN CONSTRAINT 1 IS? 1
COEFFICIENT OF VARIABLE 10 IN CONSTRAINT 1 IS? 4
COEFFICIENT OF VARIABLE 11 IN CONSTRAINT 1 IS? 5
COEFFICIENT OF VARIABLE 12 IN CONSTRAINT 1 IS? 6
COEFFICIENT OF VARIABLE 13 IN CONSTRAINT 1 IS? 9
COEFFICIENT OF VARIABLE 14 IN CONSTRAINT 1 IS? 7
COEFFICIENT OF VARIABLE 15 IN CONSTRAINT 1 IS? 8
COEFFICIENT OF VARIABLE 16 IN CONSTRAINT 1 IS? 7
AMOUNT OF RESOURCES IN CONSTRAINT 1 IS? 10
COEFFICIENT OF VARIABLE 1 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 2 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 3 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 4 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 5 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 6 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 7 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 8 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 9 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 10 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 11 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 12 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 13 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 14 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 15 IN CONSTRAINT 2 IS? 1
COEFFICIENT OF VARIABLE 16 IN CONSTRAINT 2 IS? 1
AMOUNT OF RESOURCES IN CONSTRAINT 2 IS? 1
```

Sample 2a.

constraint merely states the fact that all fractions must sum to 1. The third, fourth, fifth and sixth constraints stipulate that no one industry can represent more than 35 percent of the portfolio.

To enter this problem the user must respond to roughly 100 queries, a portion of which is provided in Sample 2a.

The outputs produced by the program in Listing 1 are shown in Sample 2b.

These outputs suggest that 35 percent of the portfolio should be invested in company 4, 30 percent in company 8 and 35 percent in company 16. Maximum return from this portfolio is 8.7. The sensitivity coefficients suggest that the second constraint is the one to which the maximum objective function value is most sensitive. However, the right-hand-side value of this constraint cannot be increased. The third and sixth constraints also influence the objective function value, as indicated by the third and sixth sensitivity coefficient values above.

Epilogue

The program shown in Listing 1 is able to solve maximization problems with ≤ inequalities. Two such problems were solved in this article. However, MP problems can also be minimization problems and can involve ≥ inequalities and equalities. One of the three programs in the Mathematical Programming System offered by Software Engineering Systems is able to solve this more general class of problems. The program uses the simplex algorithm in condensed tableau form. All slack, surplus and artificial variables required to solve a problem are inserted into the formulation automatically. As in the algorithm in Listing 1, all arrays are dynamically dimensioned to accommodate the number of variables and the number of constraints and do not require user attention.

The package sells for $29 on cassette ($33 on diskette) and includes a transportation algorithm (modified distribution method), and a network flow optimization algorithm (out-of-kilter method) in addition to the simplex algorithm.

Conclusion

Personal computers are devices with vast problem-solving capabilities. However, the literature on personal computing suggests that these capabilities have been overlooked, while other capabilities such as accounting, word processing, education and games are touted.

One such problem—the problem of maximizing profits—has been treated here. Once formulated, the problem is easily solved by the computer program in Listing 1. The solution to the problem informs the problem solver which product mix is best—that is, how much of each product (or service) to produce (or provide). In addition, the solution tells the user to which resource the profit is most sensitive. This is the resource which, if increased, will cause the greatest increase in profit. ■

```
MAXIMUM OBJECTIVE FUNCTION VALUE IS 8.7
MAXIMUM VALUE FOR VARIABLE 4 IS .35
MAXIMUM VALUE FOR VARIABLE 8 IS .3
MAXIMUM VALUE FOR VARIABLE 16 IS .35
HIT ENTER TO SEE SHADOW PRICES—OK?
SENSITIVITY COEFFICIENTS (DUAL VARIABLES) ARE
    0
    8
    1
    0
    0
    1
HIT ENTER TO END?
```

Sample 2b.

Listing continued from page 80.

```
0000            380 ;VIDEO  IS THE BEGINNING ADDRESS ASSIGNED TO THE
0000            390 ;MEMORY MAPPED VIDEO RAM.  ITS VALUE IS STORED
0000            400 ;IN THE BUFFER AREA FOR EASY MODIFICATION.
C000            410 ORIG 0C000H
C000            420 :VIDEO  ;
C000            430 ;
C000            440 ;LOC  IS THE BEGINNING ADDRESS OF THIS VIDEO
C000            450 ;DRIVER ROUTINE SOFTWARE
1030            460 ORIG 1030H
1030            470 :LOC   ;
1030            480 ;
1030            490 ;RWMAX  REPRESENTS THE MAXIMUM ROW COUNT FOR
1030            500 ;THE VIDEO SCREEN.  IT IS THE TOTAL CHARACTERS
1030            510 ;COUNT UP TO THE FIRST SPOT ON THE LAST
1030            520 ;ROW. FOR 24 LINES, THE COUNT IS 0730H
0030            530 ORIG 30H
0030            540 :RWMAXL  ;
0007            550 ORIG 7
0007            560 :RWMAXH  ;
0007            570 ;
0007            580 ;15 BYTES OF RAM ARE NEEDED FOR HOUSEKEEPING.
0007            590 ;THESE BYTES MUST BE IN AN AREA UNUSED BY
0007            600 ;OTHER PROGRAMS.  THE BASE ADDRESS IS STORED
0007            610 ;IN REGISTER IX EACH TIME THE ROUTINE IS USED.
0007            620 ;MERELY TWO ADDR CHANGES IN THIS PROGRAM WILL
0007            630 ;RELOCATE THIS BUFFER AREA.  THEY ARE LOCATED
0007            635 ;IN STATEMENTS 1110 AND 5310.
BFF0            640 ORIG 0BFF0
BFF0            650 :BUFFER  ;
BFF0            660 ;
BFF0            670 ;ASSIGN VALUES TO BUFFER POINTERS
0000            672 ORIG 0
0000            674 :SPARE  ;
0001            680 ORIG 1
0001            690 :VIDLO ;
0002            700 ORIG 2
0002            710 :VIDHI ;
0003            720 ORIG 3
0003            730 :BUFLO ;
0004            740 ORIG 4
0004            750 :BUFHI ;
0005            760 ORIG 5
0005            770 :HOMLO ;
0006            780 ORIG 6
0006            790 :HOMHI ;
0007            800 ORIG 7
0007            810 :CHARTR
0008            820 ORIG 8
0008            830 :CURLO ;
0009            840 ORIG 9
0009            850 :CURHI ;
000A            860 ORIG 0AH
000A            870 :ROWLO ;
000B            880 ORIG 0BH
000B            890 :ROWHI ;
000C            900 ORIG 0CH
000C            910 :COLUMN ;
000D            920 ORIG 0DH
000D            930 :PLOTTR ;NON-ZERO WHEN PLOTTING
000D            960 ;
000D            970 ;
000D            999 ;****************************
000D           1000 ;******* SECTION 1 *********
000D           1005 ;****************************
000D           1010 ;
000D           1020 ;  NORMAL ENTRY POINT
000D           1030 ;     EXPECTS CHARACTER OR COMMAND IN B
000D           1040 ;     RETURNS CHARACTER IN A
000D           1050 ;     PRINTS ALL BYTES LARGER THAN 0EH
000D           1060 ;
1030           1070 ORIG LOC
1030 0000      1072 FCDB 0
1032 0000      1074 FCDB 0
1034 0000      1076 FCDB 0
1036 E5        1080 PUSH HL  ;SAVE HL ON STACK
1037 D5        1090 PUSH DE  ;DE TOO
1038 C5        1100 PUSH BC  ;BC TOO
1039 DDE5      1105 PUSH IX  ;ALSO IX
103B           1106 ;            (MUST BE USER PERSONALIZED)
103B DD21F0BF  1110 LD IX,BUFFER  ;INITIALIZE BUFFER AREA
103F           1120 ;             TAKES 16 BYTES OF RAM.
103F DD7E0D    1122 LD A,(IX+PLOTTR)
1042 FE00      1124 CP 0
1044 C27B10    1126 JP .NZ,EXIT   ;DO NOT PRINT IF GRAPHICS MODE
1047 78        1130 LD A,B        ;CHARACTER TO A
1048 DD7007    1140 LD (IX+CHARTR),B  ;STORE CHAR IN BUFFER
104B D606      1150 SUB 6         ;EXIT IF CNTL-A TO CNTL-F
104D 382C      1160 JR .C,EXIT
104F FE08      1170 CP 8          ;TEST IF CHAR IS A VIDEO CMD
1051 3805      1180 JR .C,CMDVCT  ;IF SO, VECTOR TO CMD
1053 CD1611    1190 CALL CHAROT
1056 1823      1200 JR EXIT
1058           1210 ;
1058           1220 ;  TRANSFER TO VIDEO COMMAND ROUTINE
1058           1230 ;
```

More

Listing 2 continued.

```
1058 3D          1240 :CMDVCT DEC A
1059 E607        1250 AND 07H   ;MASK OFF UPPER 5 BITS
105B CB07        1260 RLC A
105D 216D10      1270 LD HL,VECTOR  ;BASE OF CMD VECTOR TABLE
1060 1600        1280 LD D,0    ;ZERO D
1062 5F          1290 LD E,A    ;MOVE OFFSET TO E
1063 19          1300 ADD HL,DE ;HL HOLDS VECTOR TABLE ADDR
1064 5E          1310 LD E,(HL) ;LOWER BYTE OF VECTOR TO E
1065 23          1320 INC HL
1066 56          1330 LD D,(HL) ;UPPER BYTE OF VECTOR TO D
1067 EB          1340 EX DE,HL  ;VECTOR TO HL
1068 117B10      1350 LD DE,EXIT ;ADDR OF EXIT ROUTINE TO DE
106B D5          1360 PUSH DE   ;STORE ON STACK FOR 'RET'
106C E9          1370 JP (HL)   ;TRANSFER PROG CNTL TO HL
106D             1380 ;
106D             1390 ;ADDR TABLE FOR VIDEOGRAPHIC COMMANDS
106D             1400 ;
106D             1405 :VECTOR  ;
106D 0B11        1410 FCDB BELLS   ;CNTL-G  RING A BELL
106F 8210        1420 FCDB BACKSP  ;CNTL-H  BACKSPACE
1071             1430 ;                 (CURSOR BACK)
1071 B410        1440 FCDB LASTRW  ;CNTL-I  CURSOR UP
1073 C510        1450 FCDB NEXTRW  ;CNTL-J  LINEFEED
1075             1460 ;                 (CURSOR DOWN)
1075 9B10        1470 FCDB FWDSP   ;CNTL-K  CURSOR FORWARD
1077 D910        1480 FCDB HOME    ;CNTL-L  CURSOR HOME
1079 EA10        1490 FCDB CRRTN   ;CNTL-M  CARRIAGE RETURN
107B             1500 ;
107B             1510 ; EXIT ROUTINE   RESTORES REGISTERS
107B             1520 ;
107B DDE1        1530 :EXIT POP IX ;RESTORE IX
107D C1          1532 POP BC       ;BC TOO
107E 78          1535 LD A,B       ;CHARACTER TO A
107F D1          1540 POP DE
1080 E1          1550 POP HL
1081 C9          1560 RET       ;RETURN TO USER'S PROGRAM
1082             1600 ;
1082             1610 ; CURSOR BACK ROUTINE
1082             1620 ;
1082 DD7E0C      1630 :BACKSP  LD A,(IX+COLUMN)  ;COLUMN CNT TO A
1085 FE00        1640 CP 0            ;IS IT ZERO?
1087 2804        1650 JR .Z,BACK1  ;IF SO, JUMP
1089 CD8011      1660 CALL REGI   ;SHIFT CURSOR 1 COLUMN LEFT
108C C9          1670 RET
108D DD360C4F    1680 :BACK1 LD (IX+COLUMN),4FH  ;LAST LINE COLMN
1091 CD6112      1690 CALL HL)ROW ;SAVE 79D IN ROW CNT
1094 CDA111      1700 CALL CALCUR ;CALCULATE NEW CURSOR
1097 CD1A12      1710 CALL CURSLD
109A C9          1720 RET
109B             1740 ;
109B             1750 ; CURSOR FORW RD ROUTINE
109B             1760 ;
109B DD7E0C      1770 :FWDSP  LD A,(IX+COLUMN)
109E FE4F        1780 CP 4FH          ;IS A LESS THAN 79D?
10A0 3004        1790 JR .NC,FWD1  ;JP IF END OF LINE
10A2 CD5D11      1800 CALL ADVI    ;ADVANCE CURSOR
10A5 C9          1805 RET
10A6 DD360C00    1810 :FWD1  LD (IX+COLUMN),0  ;ZERO COLUMN CNT
10AA CD6112      1820 CALL HL)ROW  ;ROW CNT TO HL
10AD CDA111      1830 CALL CALCUR
10B0 CD1A12      1840 CALL CURSLD
10B3 C9          1850 RET
10B4             1860 ;
10B4             1870 ; CURSOR UP ROUTINE
10B4             1880 ;
10B4 CD6112      1890 :LASTRW  CALL HL)ROW  ;ROW CNT TO HL
10B7 AF          1900 XOR A         ;ZERO A
10B8 BD          1910 CP L          ;IS L=0?
10B9 2006        1920 JR .NZ,LAST4
10BB BC          1930 CP H          ;IS H=0?
10BC 2003        1940 JR .NZ,LAST4
10BE CDDA11      1950 CALL ROLLDN  ;SINCE FIRST ROW, ROLL-DOWN
10C1 CD8E11      1960 :LAST4  CALL REGIII  ;MOVE CURSOR UP 1 ROW
10C4 C9          1970 RET
10C5             1980 ;
10C5             1990 ; CURSOR DOWN ROUTINE
10C5             2000 ;   DOES NOT CLEAR NEXT LINE IF ROLLED-UP
10C5             2010 ;
10C5 CD6112      2020 :NEXTRW CALL HL)ROW  ;ROW CNT TO HL
10C8 3E30        2030 LD A,RWMAXL   ;0730H IS ROW CNT FOR
10CA BD          2040 CP L          ;THE LAST LINE
10CB 2008        2050 JR .NZ,NEXT4 ;JP IF L#80H
10CD 3E07        2060 LD A,RWMAXH  ;NOW CHECK H
10CF BC          2070 CP H          ;IS H=7?
10D0 2003        2080 JR .NZ,NEXT4
10D2 CDB011      2090 CALL ROLLUP  ;IT IS THE LAST LINE, SO ROLL
10D5 CD6F11      2100 :NEXT4 CALL ADVIII  ;ADVANCE CURSOR 1 LINE
10D8 C9          2110 RET
10D9             2120 ;
10D9             2130 ; CURSOR HOME ROUTINE
10D9             2140 ;
10D9 DD360C00    2150 :HOME  LD (IX+COLUMN),0  ;ZERO COLUMN CNT
10DD 210000      2160 LD HL,0     ;ZERO HL
10E0 CD6812      2170 CALL ROW)HL ;ZERO ROW CNT
10E3 CDA111      2180 CALL CALCUR ;CALCULATE CURSOR'S ADDR
10E6 CD1A12      2190 CALL CURSLD ;LOAD CURSOR AT 'HOME'
```

More →

Listing 2 continued.

```
10E9 C9           RET
10EA              ;
10EA              ; CARRIAGE RETURN ROUTINE
10EA              ;    CLEARS THE NEXT LINE IF A ROLL-UP OCCURS
10EA              ;    DEPOSITS '0D' IN MEMORY AS CR
10EA              ;
10EA CD1611       :CRRTN  CALL CHAROT  ;DEP CR IN MEMORY
10ED CD6112       CALL HL)ROW ;ROW COUNT TO HL
10F0 3E30         LD A,RWMAXL ;CHECK IF LAST LINE  L=80H?
10F2 BD           CP L
10F3 200B         JR .NZ,CRR2
10F5 3E07         LD A,RWMAXH ;H=7?
10F7 BC           CP H
10F8 2006         JR .NZ,CRR2
10FA CDB011       CALL ROLLUP ;LAST LINE, SO ROLL-UP SCREEN
10FD CD0612       CALL CLRLIN ;FILL NEXT LINE W/ SPACES
1100 DD360C00     :CRR2 LD (IX+COLUMN),0  ;PUT CURSOR BOL
1104 CDA111       CALL CALCUR
1107 CD1A12       CALL CURSLD
110A C9           RET
110B              ;
110B              ; RING A BELL ROUTINE
110B              ;
110B DB00         :BELLS IN A,(00H) ;CHECK STATUS
110D E680         AND 80H       ;MASK OFF BYTE
110F 28FA         JR .Z,BELLS   ;JP BACK IF NOT READY
1111 3E07         LD A,07H      ;A HOLDS ASCII BELL
1113 D301         OUT (01H),A   ;SET I/O ADDR FOR YOUR MACHINE
1115 C9           RET
1116              ;
1116              ;  CHARACTER POSITIONING ROUTINE
1116              ;
1116 DD7E0C       :CHAROT LD A,(IX+COLUMN) ;COLUMN CNT TO A
1119 FE4F         CP 4FH          ;IS IT 79D?
111B 2807         JR .Z,CHAR2     ;JP IF LAST CHAR IN ROW
111D CD4611       CALL CHARLD     ;LOAD CHARACTER TO MEM
1120 CD5D11       CALL ADVI       ;ADVANCE CURSOR
1123 C9           RET
1124 DD7E0B       :CHAR2  LD A,(IX+ROWHI)  ;GET ROW CNT
1127 FE07         CP RWMAXH    ;CHECK IF LAST ROW
1129 2007         JR .NZ,CHAR4 ;JP IF NOT YET
112B DD7E0A       LD A,(IX+ROWLO)
112E FE30         CP RWMAXL    ;LOW BYTE MATCH?
1130 2807         JR .Z,CHAR6  ;JP IF SO, LAST LINE
1132 CD4611       :CHAR4 CALL CHARLD
1135 CD6B11       CALL ADVII
1138 C9           RET
1139 CD4611       :CHAR6 CALL CHARLD  ;LOAD CHAR IN LAST POSIT
113C CDB011       CALL ROLLUP  ;SCROLL IN A NEW LINE
113F CD0612       CALL CLRLIN  ;CLEAR NEW LINE
1142 CD6B11       CALL ADVII   ;MOVE CURSOR TO NEW LINE
1145 C9           RET
1146              ;
1146              ; LOAD CHARACTER ROUTINE
1146              ;
1146 CD6112       :CHARLD  CALL HL)ROW  ;ROW CNT TO HL
1149 CDA111       CALL CALCUR  ;CALCULATE CURSOR ADDR
114C E5           PUSH HL      ;SAVE THAT ADDR
114D CDF611       CALL CLRROW  ;CLEAR ROW CHAR TEST ROUTINE
1150 E1           POP HL
1151 CD7D12       CALL MASK8K   ;MASK END AROUND
1154 CD3E12       CALL DE)VID   ;MEMORY MAPPED VIDEO ADDR TO DE
1157 19           ADD HL,DE     ;HL NOW HOLDS ABSOLUTE ADDR
1158 DD7E07       LD A,(IX+CHARTR) ;CHAR BYTE TO A
115B 77           LD (HL),A     ;LOAD BYTE TO MEMORY
115C C9           RET
115D              ;
115D              ;**********************
115D              ;**** SECTION 2 *******
115D              ;**********************
115D              ; ELEMENTAL SUBROUTINES FOR VIDEO
115D              ;
115D              ;
115D              ;  MIDDLE OF SCREEN CURSOR ADVANCE
115D              ;     CURSOR AND COLUMN INCREMENT
115D              ;
115D DD340C       :ADVI  INC (IX+COLUMN)  ;INCREMENT COLUMN CNT
1160 CD6F12       CALL HL)CUR ;CURSOR ADDR TO HL
1163 23           INC HL      ;POINT TO NEXT CHAR
1164 CD7612       CALL CUR)HL ;STORE HL TO CURSOR
1167 CD1A12       CALL CURSLD
116A C9           RET
116B              ;
116B              ;  END OF LINE CURSOR ADVANCE
116B              ;     CURSOR AND COLUMN TO NEXT LINE
116B              ;     ROW COUNT INCREMENTS BY 1
116B              ;     CONTINUES TO ADVIII
116B              ;
116B DD360C00     :ADVII LD (IX+COLUMN),0 ;ZERO COLUMN CNT
116F              ;
116F              ;  MIDDLE OF LINE CURSOR DOWN
116F              ;     CURSOR STAYS IN SAME COLUMN BUT
116F              ;       ON THE NEXT LINE
116F              ;     EXPECTS THAT NEXT LINE IS ON SCREEN
116F              ;
116F CD6112       :ADVIII  CALL HL)ROW  ;ROW CNT TO HL
```

More

Listing 2 continued.

```
1172 115000     LD DE,50H   ;80D TO DE
1175 19         ADD HL,DE   ;HL=ROW CNT + 80D
1176 CD6812     CALL ROW)HL ;STORE NEW ROW CNT
1179 CDA111     CALL CALCUR ;CALCULATE NEW CURSOR
117C CD1A12     CALL CURSLD
117F C9         RET
1180            ;
1180            ; MIDDLE OF SCREEN CURSOR REGRESS
1180            ;     CURSOR MOVES BACK 1 LOCATION
1180            ;     CURSOR AND COLUMN CNT DECREMENTED
1180            ;
1180 DD350C     :REGI DEC (IX+COLUMN)   ;DECREMENT COLUMN CNT
1183 CD6F12     CALL HL)CUR ;CURSOR LOC TO HL
1186 2B         DEC HL
1187 CD7612     CALL CUR)HL ;SAVE NEW CURSOR
118A CD1A12     CALL CURSLD
118D C9         RET
118E            ;
118E            ;  MIDDLE OF LINE CURSOR UP
118E            ;    CURSOR REMAINS IN SAME COLUMN BUT
118E            ;    ONE LINE HIGHER
118E            ;    EXPECTS HIGHER LINE TO BE ON SCREEN
118E            ;
118E CD6112     :REGII  CALL HL)ROW
1191 115000     LD DE,50H   ;80D TO DE
1194 B7         OR A        ;CLEAR CARRY FLAG
1195 ED52       SBC HL,DE   ;HL=ROW COUNT - 80D
1197 CD6812     CALL ROW)HL ;SAVE NEW ROW CNT
119A CDA111     CALL CALCUR ;CALCULATE NEW CURSOR ADDR
119D CD1A12     CALL CURSLD
11A0 C9         RET
11A1            ;
11A1            ;  CALCULATE CURSOR ADDR ROUTINE
11A1            ;     USES HOME ADDR + COLUMN CNT
11A1            ;      + ROW CNT.  EXPECTS ROW CNT IN HL
11A1            ;
11A1 1600       :CALCUR LD D,0  ;ZERO D
11A3 DD5E0C     LD E,(IX+COLUMN) ;COLUMN CNT TO E
11A6 19         ADD HL,DE   ;HL=ROW+COLUMN
11A7 EB         EX DE,HL    ;SAVE IN DE
11A8 CD5312     CALL HL)HOM ;HOME ADDR IN HL
11AB 19         ADD HL,DE   ;HL=ROW+COLUMN+HOME
11AC CD7612     CALL CUR)HL ;STORE IN HL
11AF C9         RET
11B0            ;
11B0            ; ROLL-UP ROUTINE
11B0            ;     ROLLS SCREEN UP 1 LINE BASED ON HOME
11B0            ;     CURSOR AND COLUMN CNT STAY ON SAME CHAR
11B0            ;     DECREMENTS ROW CNT BY ONE
11B0            ;     DOES NOT CLEAR NEW LINE, 1ST CHAR ADDR
11B0            ;       ON THE NEW LINE IS IN IX+BUFF
11B0            ;
11B0 115000     :ROLLUP  LD DE,50H  ;80D TO DE
11B3 D5         PUSH DE     ;SAVE IT
11B4 CD5312     CALL HL)HOM ;HOME ADDR TO HL
11B7 19         ADD HL,DE   ;NEW HOME ADDR
11B8 CD7D12     CALL MASK8K ;ADJUST FOR END-AROUND
11BB CD5A12     CALL HOM)HL ;SAVE HOME
11BE 1607       LD D,RWMAXH ;LAST ROW HIBYTE TO D
11C0 1E30       LD E,RWMAXL ;LAST ROW LOBYTE TO E
11C2 19         ADD HL,DE   ;HL=1ST CHAR IN NEXT LINE
11C3 CD7D12     CALL MASK8K ;MASK END AROUND
11C6 CD4C12     CALL BUF)HL
11C9 B7         OR A        ;CLEAR CARRY
11CA D1         POP DE      ;80D TO DE
11CB CD6112     CALL HL)ROW ;ROW CNT TO HL
11CE ED52       SBC HL,DE   ;HL=ROW CNT - 80D
11D0 CD7D12     CALL MASK8K
11D3 CD6812     CALL ROW)HL ;SAVE NEW ROW CNT
11D6 CD2C12     CALL HOMLD  ;READDJUST VIDEO HOME ADDR
11D9 C9         RET
11DA            ;
11DA            ;  ROLL-DOWN ROUTINE
11DA            ;     ROLLS SCREEN DOWN 1 LINE
11DA            ;     INCREMENTS ROW COUNT BY ONE LINE
11DA            ;     CURSOR AND COLUMN STAY AT SAME CHAR
11DA            ;
11DA 115000     :ROLLDN LD DE,50H ;80D TO DE
11DD D5         PUSH DE
11DE CD5312     CALL HL)HOM   ;HOME ADDR TO HL
11E1 B7         OR A          ;CLEAR CARRY FLAG
11E2 ED52       SBC HL,DE     ;HL=NEW HOME ADDR
11E4 CD7D12     CALL MASK8K
11E7 CD5A12     CALL HOM)HL   ;SAVE HOME
11EA CD6112     CALL HL)ROW   ;ROW CNT TO HL
11ED D1         POP DE        ;80D IN DE
11EE 19         ADD HL,DE
11EF CD6812     CALL ROW)HL   ;SAVE NEW ROW CNT
11F2 CD2C12     CALL HOMLD    ;READJUST VIDEO HOME ADDR
11F5 C9         RET
11F6            ;
11F6            ;  CLEAR ROW TEST ROUTINE
11F6            ;     FILLS LINE W/ SP'S IF FIRST CHAR
11F6            ;     OF PRESENT LINE IS F0H
11F6            ;
11F6 CD4512     :CLRROW  CALL HL)BUFF ;LOC OF 1ST CHAR
```

More

Listing 2 continued.

```
11F9 CD3E12     CALL DE)VID  ;MEMORY MAP ADDR TO DE
11FC 3EF0       LD A,0F0H    ;CLEAR ROW DELIMITER
11FE 19         ADD HL,DE
11FF BE         CP (HL)      ;IS CHAR A 0F0H?
1200 C0         RET .NZ      ;RETURN IF NOT
1201 CD0612     CALL CLRLIN  ;FILL ROW W/ SPACES
1204 C9         RET
1205            ;
1205            ;  CLEAR LINE ROUTINE
1205            ;    EXPECTS IX+BUFF TO HOLD 1ST CHAR OF LINE
1205            ;
1205 20         :SPACE  FCB 20H  ;SPACE BYTE
1206 CD4512     :CLRLIN  CALL HL)BUFF  ;LOC OF FIRST CHAR
1209 CD3E12     CALL DE)VID  ;ABSOLUTE MEM-MAPPED ADDR TO DE
120C 19         ADD HL,DE    ;ABSOLUTE CHARACTER ADDR TO HL
120D 015000     LD BC,50H    ;COUNTER BC HOLDS 80D
1210 110512     LD DE,SPACE  ;DE POINTS TO  20H
1213 EB         EX DE,HL     ;SWITCH DE + HL
1214 EDA0       :CLR1 LDI    ;MOVE A SP TO MEMORY
1216 E0         RET .PO  ;EXIT WHEN BC=0
1217 2B         DEC HL   ;KEEP HL POINTING AT 20H
1218 18FA       JR CLR1  ;REPEAT TILL DONE
121A            ;
121A            ;  LOADS CURSOR ADDR TO 6845 CHIP
121A            ;
121A 3E0F       :CURSLD  LD A,0FH  ;CURSOR LOW REGISTER
121C D370       OUT (70H),A  ;OUTPUT REG # TO 6845
121E CD6F12     CALL HL)CUR  ;CURSOR ADDR TO HL
1221 7D         LD A,L
1222 D371       OUT (71H),A  ;OUTPUT LO BYTE
1224 3E0E       LD A,0EH
1226 D370       OUT (70H),A  ;REG # TO 6845
1228 7C         LD A,H
1229 D371       OUT (71H),A  ;OUTPUT HI BYTE
122B C9         RET
122C            ;
122C            ;  LOADS HOME ADDR TO 6845 CHIP
122C            ;
122C 3E0D       :HOMLD LD A,0DH
122E D370       OUT (70H),A  ;REG # TO 6845
1230 CD5312     CALL HL)HOM  ;HOME ADDR TO HL
1233 7D         LD A,L
1234 D371       OUT (71H),A  ;OUTPUT LO BYTE
1236 3E0C       LD A,0CH
1238 D370       OUT (70H),A
123A 7C         LD A,H
123B D371       OUT (71H),A  ;OUTPUT HI BYTE
123D C9         RET
123E            ;
123E            ;  ASSORTED LOADING ROUTINES
123E            ;
123E DD5E01     :DE)VID LD E,(IX+VIDLO)
1241 DD5602     LD D,(IX+VIDHI)
1244 C9         RET
1245 DD6E03     :HL)BUF LD L,(IX+BUFLO)
1248 DD6604     LD H,(IX+BUFHI)
124B C9         RET
124C DD7503     :BUF)HL LD (IX+BUFLO),L
124F DD7404     LD (IX+BUFHI),H
1252 C9         RET
1253 DD6E05     :HL)HOM LD L,(IX+HOMLO)
1256 DD6606     LD H,(IX+HOMHI)
1259 C9         RET
125A DD7505     :HOM)HL LD (IX+HOMLO),L
125D DD7406     LD (IX+HOMHI),H
1260 C9         RET
1261 DD6E0A     :HL)ROW LD L,(IX+ROWLO)
1264 DD660B     LD H,(IX+ROWHI)
1267 C9         RET
1268 DD750A     :ROW)HL LD (IX+ROWLO),L
126B DD740B     LD (IX+ROWHI),H
126E C9         RET
126F DD6E08     :HL)CUR LD L,(IX+CURLO)
1272 DD6609     LD H,(IX+CURHI)
1275 C9         RET
1276 DD7508     :CUR)HL LD (IX+CURLO),L
1279 DD7409     LD (IX+CURHI),H
127C C9         RET
127D            ;
127D            ;MASK8K
127D            ;  MASK OFF 3 MOST SIGNIGICANT BITS
127D            ;  OF ADDR TO SET END-AROUND ON VIDEO MAP.
127D            ;  THE MEMORY MAPPED SIZE ---- 8K.
127D            ;   NOTE: THE CURSOR IS NOT MASKED SINCE
127D            ;   IT IS AN INTERNAL COUNTER.
127D            ;
127D F5         :MASK8K PUSH AF
127E 7C         LD A,H
127F E61F       AND 1FH
1281 67         LD H,A
1282 F1         POP AF
1283 C9         RET
1284            ;
1284            ;**********************
1284            ;**** SECTION 3 *******
1284            ;**********************
```

Listing 2 continued.

```
1284                ;INITIALIZATION SECTION
1284                ;
1284                ;***CALL GRAPH AND INITIALIZE FOR GRAPHIC MODE
1284 21A112         :GRAPH LD HL,CLRMEM-1 ;POINT TO 0FFH
1287 CDA212         CALL CLRMEM
128A CDB012         CALL INITBF
128D CD2813         CALL DOTS
1290 DD340D         INC (IX+PLOTTR) ;MAKE GRAPHICS FLAG NON-ZERO
1293 C9             RET
1294                ;***CALL LTTRS AND INITIALIZE FOR CHARACTER MODE
1294 210512         :LTTRS LD HL,SPACE
1297 CDA212         CALL CLRMEM
129A CDB012         CALL INITBF
129D CDD912         CALL CHARS
12A0 C9             RET
12A1                ;
12A1                ;  FILL VIDEO MEMORY WITH SPACE OR FF'S
12A1                ;     HL MUST POINT TO CHARACTER TO BLANK SCREEN
12A1                ;
12A1 FF             FCB 0FFH
12A2 1100C0         :CLRMEM  LD DE,0C000H  ;FIRST ADDR OF 8K BOARD
12A5 010020         LD BC,2000H   ;LENGTH OF MEMORY
12A8 EDA0           :CLRMM1 LDI   ;MOVE A SPACE TO VIDEO
12AA E0             RET .PO       ;RET WHEN BC=0
12AB 2B             DEC HL        ;CONTINUE TO POINT TO FILL CHAR
12AC 18FA           JR CLRMM1     ;REPEAT
12AE 0000           FCDB 0
12B0                ;
12B0                ;   INITIALIZE VIDEOGRAPHIC BUFFER VALUES
12B0                ;
12B0 DD21F0BF       :INITBF LD IX,BUFFER  ;SET UP IX POINTER
12B4                ;   NOTE: CHANGE VALUE OF BUFFER FOR
12B4                ;         A DIFFERENT BUFFER LOCATION
12B4 210000         LD HL,0  ;ZERO HL
12B7 CD6812         CALL ROW)HL
12BA CD4C12         CALL BUF)HL
12BD CD7612         CALL CUR)HL
12C0 CD5A12         CALL HOM)HL
12C3 DD360C00       LD (IX+COLUMN),0  ;ZERO COLUMN CNT
12C7 DD360D00       LD (IX+PLOTTR),0  ;RESET GRAPHICS FLAG
12CB 2100C0         LD HL,VIDEO
12CE DD7501         LD (IX+VIDLO),L
12D1 DD7402         LD (IX+VIDHI),H
12D4 DD360D00       LD (IX+PLOTTR),0  ;RESET GRAPHICS FLAG FOR CHAR MODE
12D8 C9             RET
12D9                ;
12D9                ;  INITIALIZE THE 6845 CHIP FOR 24X80 DISPLAY
12D9                ;
12D9 0E00           :CHARS LD C,0
12DB 0666           LD B,66H ;R0 H-TOTAL
12DD CD2013         CALL CHIP
12E0 0650           LD B,50H ;R1 H-DISPLAYED
12E2 CD2013         CALL CHIP
12E5 0656           LD B,56H ;R2 H-SYNC
12E7 CD2013         CALL CHIP
12EA 060C           LD B,0CH ;R3 H-PULSE WIDTH
12EC CD2013         CALL CHIP
12EF 0618           LD B,18H ;R4 V-TOTAL
12F1 CD2013         CALL CHIP
12F4 0613           LD B,13H ;R5 V-ADJUST
12F6 CD2013         CALL CHIP
12F9 0618           LD B,18H ;R6 V-DISPLAYED
12FB CD2013         CALL CHIP
12FE 0618           LD B,18H ;R7 V-SYNC
1300 CD2013         CALL CHIP
1303 0600           LD B,0   ;R8 VIDEO MODE
1305 CD2013         CALL CHIP
1308 060B           LD B,0BH ;R9 SCANS/ROW
130A CD2013         CALL CHIP
130D 0649           LD B,49H ;R10 CURSOR LIMIT HI
130F CD2013         CALL CHIP
1312 060B           LD B,0BH ;R11 CURSOR LIMIT LO
1314 CD2013         CALL CHIP
1317 CD2C12         CALL HOMLD ;R12 + R13  HOME ADDR
131A CD1A12         CALL CURSLD  ;R14 + R15 CURSOR ADDR
131D D361           OUT (61H),A  ;PUT VIDEO BOARD IN CHAR MODE
131F C9             RET
1320                ;
1320 79             :CHIP LD A,C   ;LOAD REGISTER CNT TO A
1321 D370           OUT (70H),A    ;SEND REGISTER ADDR TO 6845
1323 0C             INC C
1324 78             LD A,B
1325 D371           OUT (71H),A    ;SEND PROGRAMMING INFO TO 6845
1327 C9             RET
1328                ;
1328                ;INITIALIZE THE 6845 FOR 256X248 DISPLAY
1328                ;
1328 D360           :DOTS OUT (60H),A ;PUT VIDEO IN GRAPHIC MODE
132A 213A13         LD HL,DOTS2
132D 0E00           LD C,0
132F 7E             :DOTS1 LD A,(HL)
1330 FEEE           CP 0EEH
1332 C8             RET .Z
1333 47             LD B,A
1334 CD2013         CALL CHIP
1337 23             INC HL
1338 18F5           JR DOTS1
```

More

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CASSETTE BAUD RATE	500/1000	500	500/1500
FLOPPY DISK CONTROLLER	SINGLE/ DOUBLE	SINGLE	SINGLE/ DOUBLE
SERIAL RS232 PORT	YES	YES	YES
PRINTER PORT	YES	YES	YES
REAL TIME CLOCK	YES	YES	YES
24 X 80 CHARACTERS	YES	NO	NO
VIDEO MONITOR	YES	YES	YES
UPPER AND LOWER CASE	YES	OPTIONAL	YES
REVERSE VIDEO	YES	NO	NO
KEYBOARD	63 KEY	53 KEY	53 KEY
NUMERIC KEY PAD	YES	NO	YES
B/W GRAPHICS, 128 X 48	YES	YES	YES
HI-RESOLUTION B/W GRAPHICS, 480 X 192	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (NTSC), 128 X 192 IN 8 COLORS	YES	NO	NO
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Listing 2 continued.

```
133A               6020 ;
133A               6030 :DOTS2 ;6845 PARAMETERS FOR GRAPHICS
133A 6640          6040 FCDB 4066H ;R0/R1
133C 4E09          6050 FCDB 094EH ;R2/R3
133E 7F19          6060 FCDB 197FH ;R4/R5
1340 7F7D          6070 FCDB 7D7FH ;R6/R7
1342 0001          6080 FCDB 0100H ;R8/R9
1344 0000          6090 FCDB 0  ;RA/RB
1346 0000          6100 FCDB 0  ;RC/RD
1348 0000          6110 FCDB 0  ;RE/RF
134A EE            6120 FCB 0EEH ;END OF FILE
134B               7000 ;
134B               7005 ;**********************
134B               7010 ;**** SECTION 4 *******
134B               7015 ;**********************
134B               7020 ;
134B               7030 ;SHORT GRAPHICS ROUTINES
134B               7040 ;
134B               7050 ;(SEE LINE 5184 TO INITIALIZE FOR GRAPHICS MODE)
134B               7055 ;
134B               7060 ;THE GRAPHICS IS A MEMORY MAPPED BIT FOR BIT
134B               7070 ;DISPLAY OF 256 ACROSS BY 248 DOWN (256X248)
134B               7075 ;
134B               7080 ;EACH BLOCK OF 4X2 DOTS IS A SINGLE BYTE MEMORY
134B               7090 ;LOCATION.  THE COMPOSITION OF THAT 4X2 BLOCK IS
134B               7100 ;AS SHOWN:     4 5 6 7
134B               7105 ;              0 1 2 3
134B               7110 ;
134B               7120 ;THE FOLLOWING ROUTINES WILL EITHER PLOT THE
134B               7125 ;CO-ORDINATE (DRAW) OR CLEAR THE COORDINATE
134B               7130 ;(UNDRAW).  THE COORDINATE IS COUNTED FROM
134B               7135 ;THE UPPER LEFT CORNER OF THE SCREEN, AND IS
134B               7140 ;PASSED TO THE ROUTINES IN THE REGISTER
134B               7145 ;PAIR DE AS FOLLOWS:
134B               7150 ;  D = X-COORDINATE  (0 TO 256)
134B               7155 ;  E = Y-COORDINATE  (0 TO 248)
134B               7160 ;
134B               7400 ;
134B               7405 :DRAW  ;ENTER WITH COORDINATE IN DE
134B               7410 ;        DRAWS DOT, AND RETURNS MEM LOC IN HL
134B C5            7420 PUSH BC
134C CD6313        7430 CALL DOTA
134F CDA413        7440 CALL SETDOT
1352 CD7B13        7450 CALL DOTB
1355 C1            7460 POP BC
1356 C9            7470 RET
1357               7480 ;
1357               7485 :UNDRAW  ;CLEARS THE DOT REQUESTED BY DE
1357               7490 ;
1357 C5            7500 PUSH BC
1358 CD6313        7510 CALL DOTA
135B CD8213        7520 CALL UNDOT
135E CD7B13        7530 CALL DOTB
1361 C1            7540 POP BC
1362 C9            7550 RET
1363               7560 ;
1363               7570 :DOTA  ;THIS ROUTINE DETERMINES THE ADDR
1363               7575 ;       OF THE DOT'S BYTE AND PUTS IT IN HL
1363               7580 ;
1363 7B            7590 LD A,E
1364 0F            7600 RRCA
1365 0F            7610 RRCA
1366 0F            7620 RRCA
1367 6F            7630 LD L,A
1368 E61F          7640 AND 1FH
136A 67            7650 LD H,A
136B 7D            7660 LD A,L
136C E6C0          7670 AND 0C0H
136E 6F            7680 LD L,A
136F 7A            7690 LD A,D
1370 CB3F          7700 SRL A
1372 CB3F          7710 SRL A
1374 B5            7720 OR L
1375 6F            7730 LD L,A
1376 0100C0        7740 LD BC,VIDEO ;BC HAS VIDEO RAM ADDR
1379 09            7750 ADD HL,BC   ;ADD TO IT THE INCREMENT
137A C9            7760 RET         ;HL POINTS TO PROPER BYTE
137B               7770 ;
137B               7780 :DOTB  ;THIS ROUTINE EXPECTS HL=POINT ADDR
137B               7790 ;       B=NEW BYTE WITH UPPER BITS modified
137B               7800 ;       A=NEW BYTE WITH LOWER BITS MODIFIED.
137B               7810 ;       USES LEAST SIGNIFICANT BIT IN E,
137B               7815 ;       THE Y-COORDINATE, TO DETERMINE WHICH
137B               7820 ;        BYTE TO STORE IN VIDEO RAM.
137B               7830 ;
137B CB43          7840 BIT 0,E
137D 2001          7850 JR .NZ,DOTB1
137F 78            7860 LD A,B
1380 77            7870 :DOTB1 LD (HL),
1381 C9            7880 RET
1382               7900 ;
1382               7910 :UNDOT  ;CLRS THE DOT IN THE BYTE POINTED
1382               7920 ;        TO BY HL BASED ON THE TWO LEAST SIG-
1382               7930 ;        NIFICANT BITS OF D (X-COORDINATE)
1382               7940 ;        USING REGISTERS A AND B
1382               7950 ;
```

More

Listing 2 continued.

```
1382 7E          7960 LD A,(HL)
1383 47          7970 LD B,A
1384 CB42        7980 BIT 0,D
1386 2809        7990 JR .Z,DOT3
1388 CB4A        8000 BIT 1,D
138A 280E        8010 JR .Z,DOT4
138C CBDF        8020 SET 3,A
138E CBF8        8030 SET 7,B
1390 C9          8040 RET
1391 CB4A        8050 :DOT3 BIT 1,D
1393 280A        8060 JR .Z,DOT5
1395 CBD7        8070 SET 2,A
1397 CBF0        8080 SET 6,B
1399 C9          8090 RET
139A CBCF        8100 :DOT4 SET 1,A
139C CBE8        8110 SET 5,B
139E C9          8120 RET
139F CBC7        8130 :DOT5 SET 0,A
13A1 CBE0        8140 SET 4,B
13A3 C9          8150 RET
13A4             8160 ;
13A4             8170 :SETDOT ;SAME AS UNDOT, BUT CREATES THE
13A4             8180 ;         DOT RATHER THAN REMOVING IT
13A4             8190 ;
13A4 7E          8200 LD A,(HL)
13A5 47          8210 LD B,A
13A6 CB42        8215 BIT 0,D
13A8 2809        8220 JR .Z,UNDOT3
13AA CB4A        8230 BIT 1,D
13AC 280E        8240 JR .Z,UNDOT4
13AE CB9F        8250 RES 3,A
13B0 CBB8        8260 RES 7,B
13B2 C9          8270 RET
13B3 CB4A        8280 :UNDOT3 BIT 1,D
13B5 280A        8290 JR .Z,UNDOT5
13B7 CB97        8300 RES 2,A
13B9 CBB0        8310 RES 6,B
13BB C9          8320 RET
13BC CB8F        8330 :UNDOT4 RES 1,A
13BE CBA8        8340 RES 5,B
13C0 C9          8350 RET
13C1 CB87        8360 :UNDOT5 RES 0,A
13C3 CBA0        8370 RES 4,B
13C5 C9          8380 RET
13C6             8600 ;
13C6             8610 ;LINE ROUTINE    THIS ROUTINE CALCULATES A POINT
13C6             8620 ;     TO POINT LINE BETWEEN ANY TWO INPUTTED-POINTS.
13C6             8630 ;     IT IS DESIGNED FOR A 256X248 MATRIX USING A
13C6             8640 ;     STACK-ORIENTED ALGORITHM.  THIS ROUTINE IS A
13C6             8650 ;     MODIFICATION OF A ROUTINE FROM A 'BYTE' ARTICLE
13C6             8660 ;     BY JOHN BEETEM IN THE OCTOBER 1980 ISSUE.
13C6             8670 ;
13C6             8680 ;     THE BASIS OF THIS ALGORITHM IS THAT IT SUBDIVIDES
13C6             8690 ;     A LINE BY TWO, RECURSIVELY, UNTIL THEY CAN PLOT
13C6             8700 ;     AS A SINGLE POINT.  IT THEN REPEATS ITSELF ON
13C6             8710 ;     OTHER LINE SEGMENTS UNTIL THE LINE IS FINISHED.
13C6             8715 ;     40 BYTES OF STACK USAGE IS NEEDED FOR THIS ROUTINE.
13C6             8720 ;
13C6             8730 ;TWO ENTRY MODES ARE PROVIDED:
13C6             8740 ;     MODE 1 --- 'VEC1' --- THE TWO ENDPOINTS ARE ENTERED
13C6             8750 ;           ON THE STACK.  PUSH THE POINTS ON THE STACK
13C6             8760 ;           FOLLOWED BY THE RETURN ADDRESS.
13C6             8770 ;     MODE 2 --- 'VEC2' --- ENTER THE TWO ENDPOINTS
13C6             8775 ;     AS FOLLOWS:
13C6             8780 ;           POINT 1 IN DE  (X COMPONENT IS D)
13C6             8790 ;           POINT 2 IN HL  (Y COMPONENT IS L)
13C6             8800 ;
13C6             8900 :VEC1  ;HIGHER LEVEL PROGRAM ENTRY POINT
13C6 D1          8910 POP DE ;GET 1ST POINT
13C7 E1          8920 POP HL ;GET 2ND POINT
13C8 CDCC13      8930 CALL VEC2
13CB C9          8940 RET    ;RETURN TO HIGHER LEVEL CALLING PROGRAM
13CC             8950 ;
13CC             8960 :VEC2   ;BASE LINE DRAWING ROUTINE
13CC 010000      8970 LD BC,0  ;STACK FINISHED FLAG
13CF C5          8980 PUSH BC
13D0 7A          8990 LD A,D
13D1 BC          9000 CP H      ;MAKE DE THE SMALLER #
13D2 3807        9010 JR .C,NOXG
13D4 2004        9020 JR .NZ,XNG
13D6 7B          9030 LD A,E
13D7 BD          9040 CP L
13D8 3801        9050 JR .C,NOXG
13DA EB          9060 :XNG EX DE,HL  ;TRADE DE WITH HL
13DB             9070 :NOXG          ;CHOOSE LOOP1 OR LOOP2 BASED
13DB             9080 ;               RELATIVE Y-COORDINATE VALUES
13DB E5          9090 PUSH HL
13DC C1          9100 POP BC   ;BC=HL
13DD 7B          9110 LD A,E
13DE B9          9120 CP C
13DF 3828        9130 JR .C,LOOP2
13E1             9140 ;
13E1             9150 :LOOP1
13E1 7A          9160 LD A,D     ;COMPARE X-VALUES
13E2 B8          9170 CP B
13E3 2812        9180 JR .Z,EQX1
```

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Listing 2 continued.

```
13E5 C5          9190 PUSH BC  ;SINCE X1#X2, SAVE OLD 2ND POINT
13E6 80          9200 ADD A,B  ;  AS FUTURE 1ST POINT
13E7 1F          9210 RRA      ;COMPUTE X HALFWAY POINT
13E8 47          9220 LD B,A   ;INSTALL AS NEW 2ND X
13E9 3C          9230 INC A    ;INCR TO FORM X-MIDPOINT
13EA 67          9240 LD H,A   ;INSTALL NEW X-MIDPOINT
13EB 7B          9250 LD A,E   ;NOW X1#X2, SO COMPARE Y VALUES
13EC B9          9260 CP C
13ED 2804        9270 JR .Z,EQY1  ;JMP IF NEW Y-MID NOT NEEDED
13EF 81          9280 :NEQY1 ADD A,C  ;SINCE Y1#Y2,
13F0 1F          9290 RRA       ;COMPUTE NEW Y-MIDPOINT
13F1 4F          9300 LD C,A    ;PUT INTO C AND
13F2 0C          9310 INC C     ;INCR TO FORM NEW Y2
13F3 6F          9320 :EQY1 LD L,A  ;SINCE NEITHER X'S OR Y'S EQUAL
13F4 E5          9330 PUSH HL  ;SAVE MIDPOINT AS FUTURE 2ND POINT
13F5 18EA        9340 JR LOOP1 ;CONTINUE ON DIFFERENT SEGMENT
13F7 7B          9350 :EQX1 LD A,E  ;SINCE X1=X2, THEN COMPARE
13F8 B9          9360 CP C     ;  Y VALUES.
13F9 2804        9370 JR .Z,EQXY1    ;IF Y1=Y2, JMP AND PLOT
13FB C5          9380 PUSH BC  ;OTHERWISE, SAVE 2ND POINT AS FUTURE
13FC 62          9390 LD H,D   ;  1ST POINT.  MAKE MIDPOINT X=X1
13FD 18F0        9400 JR NEQY1
13FF CD4B13      9410 :EQXY1 CALL DRAW ;PLOT COORDINATES IN DE
1402 D1          9420 POP DE   ;RETRIEVE ANOTHER SEGMENT'S 1ST POINT
1403 7A          9430 LD A,D   ;CHECK IF STACK EMPTY
1404 B3          9435 OR E
1405 C8          9440 RET .Z   ;DONE IF ZERO
1406 C1          9450 POP BC   ;RETRIEVE ANOTHER SEGMENT'S 2ND POINT
1407 18D8        9460 JR LOOP1 ;JP BACK TO KEEP MAKING LINE
1409             9500 ;
1409             9510 :LOOP2 ;SAME INSTS AS LOOP1 EXCEPT LINE 9680,
1409             9520 ;        SO THE REMARKS WILL BE OMMITTED.
1409 7A          9530 LD A,D
140A B8          9540 CP B
140B 2812        9550 JR .Z,EQX2
140D C5          9560 PUSH BC
140E 80          9570 ADD A,B
140F 1F          9580 RRA
1410 47          9590 LD B,A
1411 3C          9600 INC A
1412 67          9610 LD H,A
1413 7B          9620 LD A,E
1414 B9          9630 CP C
1415 2804        9640 JR .Z,EQY2
1417 81          9650 :NEQY2 ADD A,C
1418 1F          9660 RRA
1419 4F          9670 LD C,A
141A 3C          9680 INC A  ;THIS STATEMENT IS DIFFERENT THAN LOOP1
141B 6F          9690 :EQY2 LD L,A
141C E5          9700 PUSH HL
141D 18EA        9710 JR LOOP2
141F 7B          9720 :EQX2 LD A,E
1420 B9          9730 CP C
1421 2804        9740 JR .Z,EQXY2
1423 C5          9750 PUSH BC
1424 62          9760 LD H,D
1425 18F0        9770 JR NEQY2
1427 CD4B13      9780 :EQXY2 CALL DRAW
142A D1          9790 POP DE
142B 7A          9800 LD A,D
142C B3          9810 OR E
142D C8          9820 RET .Z
142E C1          9830 POP BC
142F 18D8        9840 JR LOOP2
1431 D1         10000 POP DE
1432 CD4B13     10010 CALL DRAW
1435 C9         10020 RET

        0406    ADVI    115D    ADVII   116B    ADVIII  116F
BACK1   108D    BACKSP  1082    BELLS   110B    BUFFER  BFF0
BUFHI   0004    BUFLO   0003    BUF)HL  124C    CALCUR  11A1
CHAR2   1124    CHAR4   1132    CHAR6   1139    CHARLD  1146
CHAROT  1116    CHARS   12D9    CHARTR  0007    CHIP    1320
CLR1    1214    CLRLIN  1206    CLRMEM  12A2    CLRMM1  12A8
CLRROW  11F6    CMDVCT  1058    COLUMN  000C    CRR2    1100
CRRTN   10EA    CURHI   0009    CURLO   0008    CURSLD  121A
CUR)HL  1276    DE)VID  123E    DOT3    1391    DOT4    139A
DOT5    139F    DOTA    1363    DOTB    137B    DOTB1   1380
DOTS    1328    DOTS1   132F    DOTS2   133A    DRAW    134B
EQX1    13F7    EQX2    141F    EQXY1   13FF    EQXY2   1427
EQY1    13F3    EQY2    141B    EXIT    107B    FWD1    10A6
FWDSP   109B    GRAPH   1284    HL)BUF  1245    HL)CUR  126F
HL)HOM  1253    HL)ROW  1261    HOME    10D9    HOMHI   0006
HOMLD   122C    HOMLO   0005    HOM)HL  125A    INITBF  12B0
LAST4   10C1    LASTRW  10B4    LOC     1030    LOOP1   13E1
LOOP2   1409    LTTRS   1294    MASK8K  127D    NEQY1   13EF
NEQY2   1417    NEXT4   10D5    NEXTRW  10C5    NOXG    13DB
PLOTTR  000D    REGI    1180    REGIII  118E    ROLLDN  11DA
ROLLUP  11B0    ROWHI   000B    ROWLO   000A    ROW)HL  1268
RWMAXH  0007    RWMAXL  0030    SETDOT  13A4    SPACE   1205
SPARE   0000    UNDOT   1382    UNDOT3  13B3    UNDOT4  13BC
UNDOT5  13C1    UNDRAW  1357    VEC1    13C6    VEC2    13CC
VECTOR  106D    VIDEO   C000    VIDHI   0002    VIDLO   0001
XNG     13DA    :
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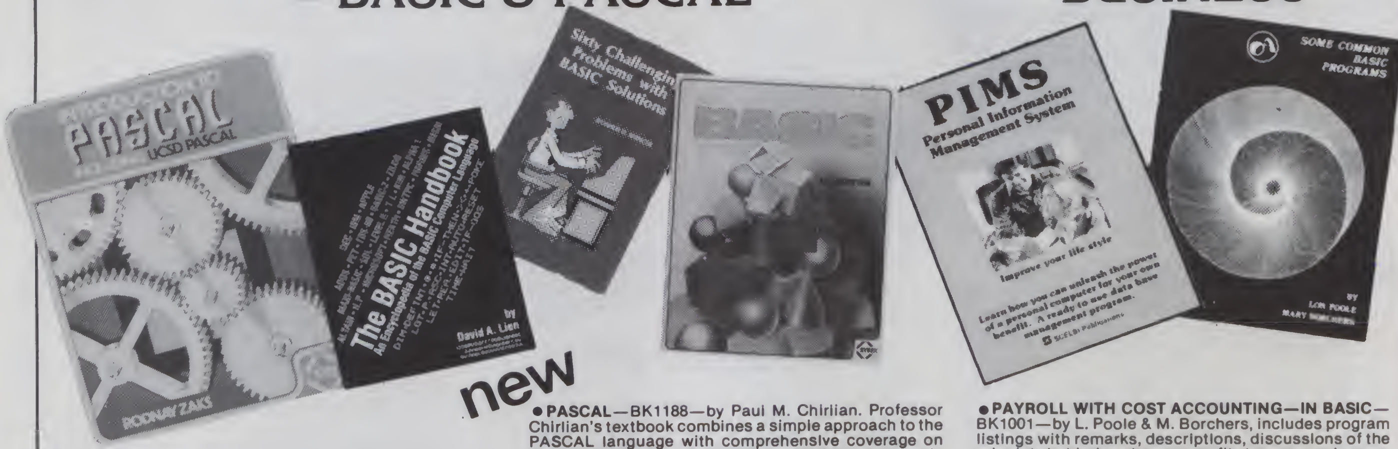

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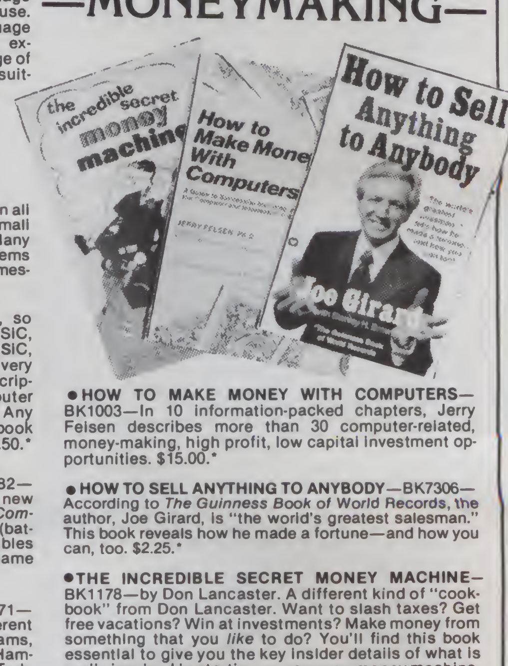

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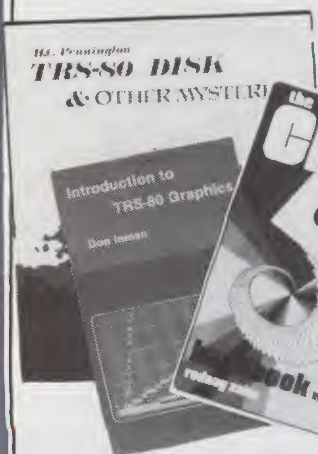

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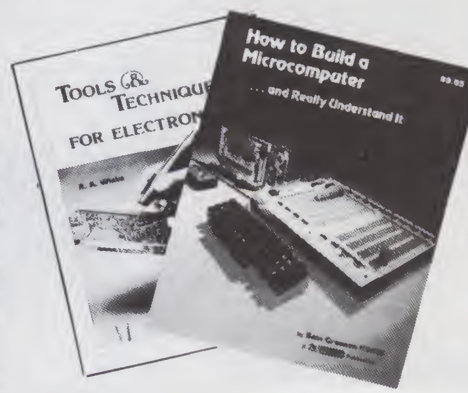

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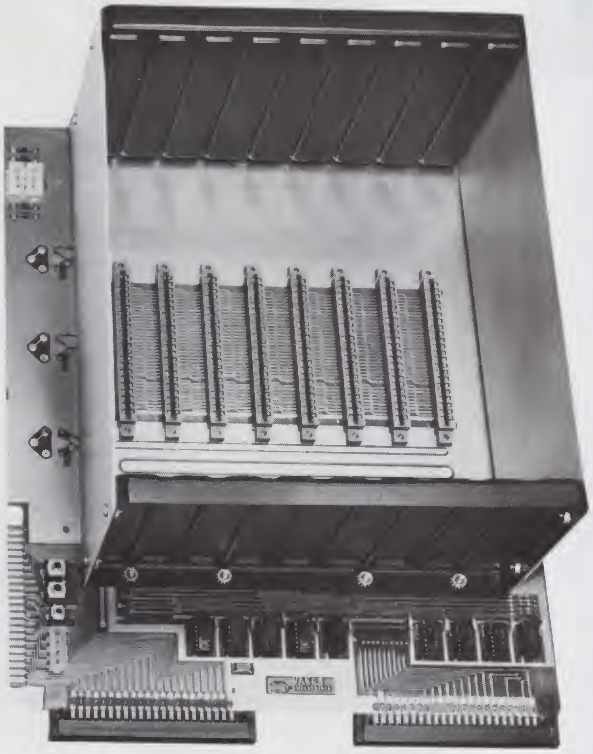

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- Uses the KIM-4* Bus (both electrical Pin-out and card size) for expansion board slots
- Provides 8 slots for expansion boards on 1″ centers to allow for wire-wrap boards
- Designed for use with a Regulated Power Supply (such as our VAK-EPS) but has provisions for adding regulators for use with an unregulated power supply.
- Provides separate jacks for one audio-cassette, TTY and Power Supply.
- Board size: 14.5 in. Long x 11.5 in. Wide x 8 in. High
- Power requirements; 5V.DC @ 0.2 Amps.

**KIM-4 is a product of MOS Technology/C.B.M.*

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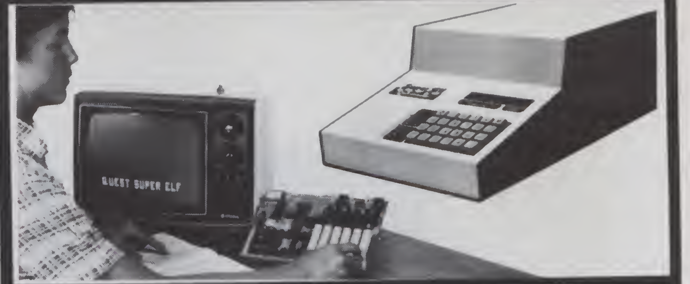

INTEGRATED CIRCUITS

7400TTL	
7400N	19
7402N	20
7404N	25
7409N	27
7410N	25
7414N	70
7420N	25
7422N	39
7430N	25
7442N	58
7445N	82
7447N	63
7448N	77
7450N	25
7474N	35
7475N	49
7485N	88
7489N	1 70
7490N	43
7492N	43
7493N	43
7495N	69
74100N	1 35
74107N	35
74121N	34
74123N	59
74125N	45
74145N	77
74150N	1 20
74151N	69
74154N	1 25
74157N	69
74161N	87
74162N	85
74163N	87
74174N	96
74175N	85
74190N	1 15
74192N	87
74193N	85
74221N	1 25
74298N	1 65
74365N	75
74366N	75
74367N	75

74LS00 TTL	
74LS00N	29
74LS02N	29
74LS04N	35
74LS05N	25
74LS08N	35
74LS10N	35
74LS13N	55
74LS14N	1 00
74LS20N	35
74LS22N	35
74LS28N	35
74LS30N	35
74LS33N	60
74LS38N	50
74LS74N	45
74LS75N	65
74LS90N	60
74LS93N	75
74LS95N	1 00
74LS107N	45
74LS112N	45
74LS113N	45
74LS132N	89
74LS136N	50
74LS151N	75
74LS155N	79
74LS157N	1 10
74LS162N	1 10
74LS163N	1 10
74LS174N	1 15
74LS190N	1 25
74LS221N	1 25
74LS258N	1 00
74LS367N	89

LINEAR	
CA3045	90
CA3046	1 10
CA3081	1 80
CA3082	1 90
CA3089	3 40
LM301AN AH	35
LM305H	87
LM307N	35
LM308N	1 00
LM309K	1 25
LM311H N	90
LM317T	1 65
LM317K	3 75
LM318	1 50
LM320K-5	1 35
LM320K-12	1 35
LM320K 15	1 35
LM320T-5	95
LM320T-8	95
LM320T-12	95
LM320T-15	95
LM323K 5	5 95
LM324N	1 00
LM339N	1 00
LM340K-5	1 35
LM340K-8	1 35
LM340K-12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	85
LM340T-8	85
LM340T-12	85
LM340T-15	85
LM340T-18	85
LM340T-24	85
LM350	5 50
LM377	2 95
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM709H	59
LM723H N	50
LM733N	85
LM741CH	35
LM741N	38
LM747H N	75
LM748N	50
LM1303N	1 75
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	1 95
LM1458	55
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	2 25
LM3900N	60
LM3905	1 75
LM3909N	95
MC1458V	55
NE550N	1 35
NE555V	39
NE556A	85
NE565A	1 00
NE566V	1 50
NE567V	1 00
NE570B	4 75
78L05	60
78L08	60
78M05	85
75108	1 75
75491CN	50
75492CN	55
75494CN	89

A to D CONVERTER	
8038B	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV F	7 40
ICL7103	9 50
ICL7107	14 25

CMOS	
CD4000	25
CD4001	35
CD4002	35
CD4006	1 10
CD4007	35
CD4008	1 20
CD4009	45
CD4010	45
CD4011	35
CD4012	28
CD4013	47
CD4014	1 25
CD4015	1 00
CD4016	55
CD4017	1 05
CD4018	94
CD4019	45
CD4020	1 02
CD4021	1 35
CD4022	1 10
CD4023	28
CD4024	75
CD4025	28
CD4026	2 50
CD4027	66
CD4028	85
CD4029	1 35
CD4030	45
CD4035	1 00
CD4040	1 35
CD4042	85
CD4043	85
CD4044	85
CD4046	1 67
CD4049	45
CD4050	60
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	50
CD4071	45
CD4072	45
CD4073	45
CD4075	45
CD4076	1 45
CD4078	40
CD4081	35
CD4082	35
CD4116	47
CD4490	5 50
CD4507	1 00
CD4508	2 85
CD4510	1 00
CD4511	94
CD4515	2 52
CD4516	1 10
CD4518	1 50
CD4520	1 02
CD4527	1 51
CD4528	1 60
CD4553	3 50
CD4566	2 45
CD4583	2 35
CD4585	1 10
CD40192	3 00
74C00	35
74C04	40
74C10	35
74C14	89
74C20	35
74C30	35
74C48	1 95
74C74	85
74C76	1 25
74C90	1 25
74C93	1 25
74C154	3 50
74C160	2 75
74C175	1 35
74C192	1 65
74C221	1 90
74C905	6 00
74C906	75
74C914	1 95
74C922	5 00
74C923	5 50
74C925	7 50
74C926	6 95
74C927	6 95

INTERFACE	
8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69

MOS/MEMORY RAM	
2101 1	2 95
2102-1	95
2102AL-4	1 45
2102AN-2L	1 65
2104A 4	4 95
21078-4	3 75
2111 1	3 75
2112-2	3 95
2114	3 75
2114L 300ns	4 25
2114L 450ns	4 00
4116 200ns	3 95
8 4116 200ns	18 40
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165-5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM66751A	9 95
9368	3 50
410D	10 00
416	16 00

CLOCKS	
MM5311	5 50
MM5312	3 90
MM5314	3 90
MM5369	2 10
MM5841	14 45
MM5865	7 95
CT7010	8 95
CT7015	8 95
MM5375AA N	3 90
MM5375AG N	4 90
7205	16 50
7207	7 50
7208	15 95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50

MICROPROCESSOR	
6502	10 95
6504	9 95
6522	9 95
6800	6 95
6802	11 95
6820	4 95
6850	5 95
8080A	3 95
8085	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3 95
8216	2 90
8224	3 45
8228	4 95
8251	6 95
8253	15 00
8255	5 75
8257	10 95
8259	14 95
1802CP plas	13 95
1802DP plas	17 95
1861P	9 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1816P	7 95

UART/FIFO	
AY5-1013	5 50
AY5-1014	7 50
3341	6 95

PROM	
1702A	5 85
2708	6 10
2716T1	12 00
2716 5 Volt	10 50
8 2716 5 Volt	64 00
2732	19 95
2758	14 00
8741A	55 00
8748	55 00
8748-8	55 00
8755A	55 00
N82S23	2 95
N82S123	4 95
N82S126	4 75
N82S129	4 95
N82S131	4 95
N82S136	8 75
N82S137	8 75
DM8577	2 90
8223	3 50

CONNECTORS	
30 pin edge	2 50
44 pin edge	2 75
86 pin edge	4 00
100 pin edge	4 50
100 pin edge WW	5 25

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	55	24	93
16	57	28	1 00
18	67	40	1 59

CRYSTALS	
1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 Hz	4 00
1 8432 MHz	4 50
3 5795 MHz	1 20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4 50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

KEYBOARD ENCODERS	
AY5-2376	$12 50
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AY5-9200	16 50
74C922	5 50
74C923	5 50
HD0165-5	6 95
AY5-9400	10 50

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DB25S	5 20
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DE9S	1 95
DA15P	2 10
DA15S	3 10
Complete Set	9 50

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10 per type	03
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100 per type	015
1000 per type	012
350 piece pack 5 per type	6 75

½ watt 5% per type 05

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Model 912	$785 00
Model 920	$885 00

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56 key ASCII keyboard kit	$67 50
Fully assembled	77 50
53 key ASCII keyboard kit	60 00
Fully assembled	70 00
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Metal Enclosure	29 95

LEDS	
Red T018	15
Green, Yellow T018	20
Jumbo Red	20
Green Orange Yellow Jumbo	25
Cliplite LED Mounting Clips	8/$1 25

(specify red, amber, green, yellow, clear)

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Complete line of breadboard test equip
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3 pos slide	25
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30 MHz Frequency Counter Kit	**$47.75**

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12 Volt 300 ma transformer	1 25
12 6V CT 600 ma	3 75
12V 250 ma wall plug	2 95
12V CT 250 ma wall plug	3 75
24V CT 100 ma	3 95
10V 1 2 amp wall plug	4 85
12V 6 amp	12 95
12V 500 ma wall plug	4 75
12V 1 amp wall plug	6 50
10/15 VAC 8/16 VA wall plug	9 75

DISPLAY LEDS			
MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72/74	CA/CA	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1 00
DL727 728	CA/CC	500	1 90
DL747 750	CA/CC	600	1 95
FND359	CC	357	70
FND500 507	CC/CA	500	1 35
FND503/510	CC/CA	500	90
FND800/807	CC/CA	800	2 20
3 digit Bubble			60
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	1 35
MAN6740	CC	60	1 35

MA1002A, C, E	**8 95**
MA1012A	**8.95**
102P3 transformer	**2.25**
MA1012A Transformer	**2.25**

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4-position	$ 95	7-position	1 00
5-position	1 00	8-position	1 05
6-position	1 00		

4116 200ns Dynamic RAM 8/$18.40

RCA Cosmac 1802 Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded** with **additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during** and **after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Free 14 page brochure.

Moews Video Graphics **$3.50.** Games and Music **$3.00**, Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow **you** to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system *(see Multi-volt Power Supply).*

Quest Super Basic V5.0

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm.17E^{38}$), 32 bit integer ± 2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

New improved faster version including **renumber** and essentially **unlimited variables.** Also, an exclusive user expandable command library.

Serial and Parallel I/O included.
Super Basic on Cassette $55.00.

PROM Eraser

assembled. 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/UL version **$69.50** (with timer **$94.50**).

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50.** Full Kit **$99.00.** Monitor **$20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

S-100 Computer Boards

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16K Static Godbout Econo XIV Kit	269.00
24K Static Godbout Econo XX-24 Kit	414.00
32K Static Godbout Econo XX-32 Kit	537.00
16K Dynamic RAM Kit	289.00
32K Dynamic RAM Kit	328.00
64K Dynamic RAM Kit	399.00
Video Interface Kit	$161.00
Color Video Kit	129.95

81 IC Update Master Manual $79.95

Comp. IC data selector, 2 vol. master reference guide. Over 51,000 cross references. Free update service through 1981. Domestic postage $4.75.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included. Bd. only $17.00. Article in May *Radio Electronics*.

LRC 7000 + Printer $389.00

64/40/32/20 column dot matrix impact, std. paper. Interface all personal computers.

LRC 7000 printer interface cable for Super Elf with software $35.00

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$9.95**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. **$405.00.** 4K version **$450.00.** 4K Assembler **$85.00.** 8K Basic Interpreter **$100.00.**

Special small power supply for AIM65 assem. in frame **$54.00.** Complete AIM65 in thin briefcase with power supply **$499.00.** Molded plastic enclosure to fit both AIM65 and power supply **$47.50.** Special Package Price: 4K AIM, 8K Basic, power supply, cabinet **$625.00.**

AIM65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95.**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Video Modulator Kit $9.95

Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option. ±5v, ±12v are regulated. Basic Kit **$35.95.** Kit with chassis and all hardware **$51.95.** Add $5.00 shipping. Kit of hardware **$16.00.** Woodgrain case **$10.00.** $1.50 shipping.

Ohio Scientific Computers

CIP Series 2 **$447.00.** Like an Apple at less than half the price! CIPMF Series 2 **$1199.00.** Minifloppy version with additional RAM/ROM. Complete software and peripherals available. Send for free brochure.

Gremlin Color Video Kit $69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

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Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$25.00**

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(added commands include Stringy, Array, Cassette I/O etc.) S-100 4-Slot Expansion $ 9.95
Super Monitor VI.I Source Listing $15.00

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Dealers: Send for excellent pricing/margin program.

Editor Assembler $25.00
(Requires minimum of 4K for E/A plus user source)
1802 Tiny Basic Source listing $19.00
Super Monitor V2.0/2.1 Source Listing $20.00

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
$10.00 min. BankAmericard and Master Charge accepted. $1.00 insurance optional.
Postage: Add 5%. C.O.D. $10.00 min. order.

FREE: Send for your copy of our NEW 1981 QUEST CATALOG. Include 48¢ stamp.

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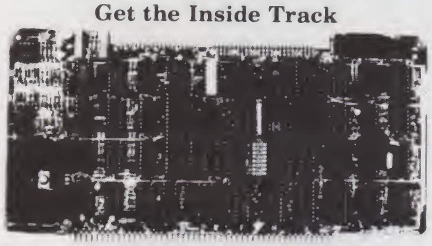
Double-D ™

Get the Inside Track



S-100 bus compatible • Reads and writes single or double density • Density is software selectable • CP/M® 2.2 compatible in single or double density • Controls up to four 5-1/4" or 8", single or double-sided drives • Single or double-sided drives may be mixed in the same system • On-board Z-80A to assure reliable operation • EIA level serial printer interface on board, baud rates to 9600 (perfect for despooling operations) • 2K of RAM on-board • Uses IBM standard formats • Designed to meet IEEE signal disciplines • Works with 8080, 8085, and Z-80 CPU's • 4-layer PC board with internal power and ground planes provides very stable, low-noise operation.

IOD-1200B *Bare board* **$59.95**
IOD-1200K *Kit* **$299.95**
IOD-1200A *A & T for 8"* **$375.95**
IOD-1205A *A & T for 5¼"* **$395.00**
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JADE

Memory Bank ™

8 or 16 Bit Dynamic Memory

New, from JADE (naturally), an IEEE S-100 64K dynamic memory that looks toward the future. • IEEE S-100 standard pinout and signal discipline • Expandable to 16 Megabytes via switchable port OR extended address lines • 8 or 16 bit words, automatically, depending on the type of CPU on the bus • 4-layer PC board for extremely low-noise operation.

The new JADE Memory Bank™ is one of the safest places you can store your valuable program information. With its on-board refresh controller, this board allows DMA operations without regard to time factors. It will run reliably at any system clock rate up to 6 MHz--because it is clocked with the system clock itself (no one-shots are used for timing operations). Its unique IEEE design enables it to switch from a 64K by 8-bit board to a 32K by 16-bit board automatically (responds to IEEE's 16 Rqst line and, if enabled, replies with 16 Grant).

On-board M1 wait-state generator allows the use of slower memory, and a unique on-board precharge extender makes this board run reliably with any manufacturer's 4116 memory chips.

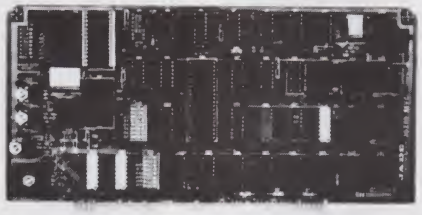
Compatible with Cromemco and other CPU systems – features enough optional strapping to enable it to run with any Z-80/Z8000 system.

MEM-99730B *Bare Board* **$49.95**
MEM-99730K *Kit, no RAM* **$199.95**
MEM-16730K *16K kit* **$219.95**
MEM-32731K *32K kit* **$239.95**
MEM-48732K *48K kit* **$259.95**
MEM-64733K *64K kit* **$279.95**
Assembled & Tested .... *add* **$50.00**

JADE

The Big Z ™

Z-80A Based CPU



S-100 bus compatible • Switch selectable 2 or 4 MHz operation • Serial I/O port • Accomodates a 2708, 2716, or 2732 EPROM in shadow mode allowing full use of 64K RAM • MWRITE signal is generated automatically if used without front panel • On-board 8251 USART controls serial port at baud rates from 75 to 9600 baud • Switch selectable 1K, 2K, or 4K boundary fully buffered • Power-on jump to EPROM

CPU-30201K *Kit* **$139.95**
CPU-30201A *A & T* **$189.95**
CPU-30200B *Bare board* **$35.00**

Memory Chips on Sale

	• 1-9	10-24	25-49	50+
2114L *4 MHz*	3.35	2.99	2.75	2.49
2708 *2 MHz*	4.90	3.90	3.45	2.90
2532 *2 MHz*	24.90	19.90	15.90	12.90
2716 *2 MHz*	8.90	7.45	6.45	5.75
2716 *4 MHz*	19.90	15.45	13.45	11.75
2732 *2 MHz*	24.90	19.90	15.90	12.90
2732 *4 MHz*	39.90	29.90	24.90	19.90
2758 *2 MHz*	6.90	6.25	5.50	4.50
4116 *200 ns*	3.25	2.99	2.49	1.99
4164 *200 ns*	28.90	24.90	22.90	19.90

JADE

Disk Sub-Systems

Shugart, Siemens, Qume

Handsome metal cabinet with proportionally balanced air flow system • Rugged dual drive power supply • Power cable kit • Power switch, line cord, fuse holder, cooling fan • Never-Mar rubber feet • All necessary hardware to mount 2-8" disk drives, power supply, and fan • Does not include signal cable

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END-000424 *A & T w/2 FD100-8Ds* **$1175.00**
END-000433 *Kit w/2 SA-801Rs* ... **$999.95**
END-000434 *A & T w/2 SA-801Rs* **$1195.00**

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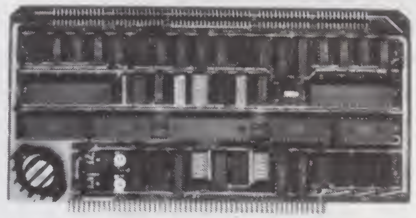
END-000437 *A & T w/2 SA-851Rs* **$1695.00**

JADE

S.P.I.C.

Our "SPICy" New I/O Board



New, from JADE, one of the most advanced, technologically sophisticated Serial/Parallel Interrupt Controller systems in the world. On a single IEEE S-100 standard board, JADE has packed two bi-directional parallel ports with full handshaking, four serial channels (asynchronous, IBM-compatible bi-synch, synchronous, HDLC/SDLC) with complete modem control lines, and 16 counter-timer channels.

Utilizing the highly advanced Zilog peripheral chips, (Z-80 SIO, PIO & CTCs), the SPIC board is fully programmable to serve as the foundation for a multi-user multi-tasking system. Although the board can be operated in an 8080/8085 system, we recommend its use with a Z-80/Z8000 system utilizing the powerful Z-80/Z8000 interrupt Mode 2. Each of the seven Z-80 peripheral chips can generate its own interrupt vector, with daisy-chain priority levels. Each counter-timer channel can be programmed to monitor an interrupt vector line on the S-100 bus, to serve as an interval timer or real-time clock, and to operate as a software controllable baud rate generator. Each SIO channel can be driven independently with separate Tx/Rx clocks for each channel, so your peripherals can have varied baud rates, from 110 to 76,800 baud

In addition, this board can serve as a data concentrator link to an IBM, DEC, or Data General mainframe computer, utilizing a high-speed serial channel that is programmable to virtually any protocol.

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IOI-1045A *A & T, standard* **$239.95**
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IOI-1046A *A & T w/full chip set* ... **$299.95**

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Includes; General Ledger, Payroll, Invoicing, Inventory Controll, Accounts Recievable, Cash Disbursements, Fixed Assets, Cash Receipts, & Mailing List Management.

Special Package Price ***$249.95***

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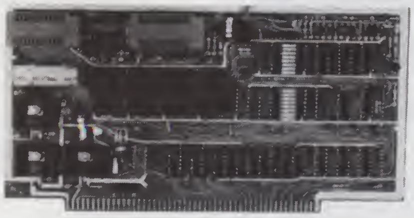
S-100 PROM Boards



PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer
MEM-99510K *Kit* $154.95
MEM-99510A *A & T* $219.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758, & 2516 EPROM programmer
MEM-99520K *Kit* $219.95
MEM-99520A *Jade A & T* $269.95

EPROM BOARD - Jade
16K or 32K uses 2708's or 2716's, 1K boundary
MEM-16230K *Kit* $79.95
MEM-16230A *A & T* $119.95

S-100 Video

VB-3 - S.S.M.
80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board input.
IOV-1095K *4 MHz kit* $349.95
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IOV-1096K *80 x 48 upgrade* $39.95

VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O, and on-board Z-80A.*
IOV-1020K *Kit* $399.95
IOV-1020A *Jade A & T* $459.95

VIDEO BOARD - Jade
64 characters x 16 lines, 7 x 9 dot matrix, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100.
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IOV-1050A *A & T* $125.00
IOV-1050B *Bare board* $29.95

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Silent, simple, and on sale - a better motherboard
6 Slot (5¼" x 8⅝")
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MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95
12 Slot (9¾" x 8⅝")
MBS-121B *Bare board* $29.95
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MBS-181A *A & T* $139.95

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MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply
ENC-112105 *Kit* $379.95
ENC-112106 *A & T* $409.95

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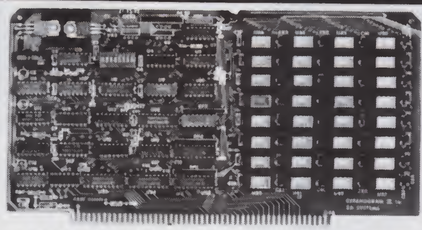
ENS-112320 *with 25 amp p.s.* $699.95

S-100 Memory



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MEM-32631K *32K kit* $295.95
MEM-48632K *48K kit* $315.95
MEM-64633K *64K kit* $335.95
Assembled & tested .... add $50.00

64K RAM - Calif Computer Sys
4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable, PHANTOM line allows memory overlay, 8080 / Z-80 / front panel compatible.
MEM-64565A *A & T* $575.00

32K STATIC RAM - Jade
2 or 4 MHz expandable static RAM board uses 2114L's
MEM-16151K *16K 4 MHz kit* $169.95
MEM-32151K *32K 4 MHz kit* $299.95
Assembled & tested .... add $50.00

16K STATIC RAM - Mem Merchant
4 MHz 16K static RAM board, IEEE S-100, bank selectable, Phantom capability, addressable in 4K blocks, "disable-able" in 1K segments, extended addressing, low power
MEM-16171A *A & T* $174.95

S-100 Disk Controller

DOUBLE DENSITY - Cal Comp Sys
5¼" and 8" disk controller, single or double density, with on-board boot loader ROM, and free CP/M 2.2 and manual set.*
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New double density controller for both 8" & 5¼"
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Special sale price* .... *2 for $1160.00

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5¼" Diskettes *Box of 10* .. $22.00
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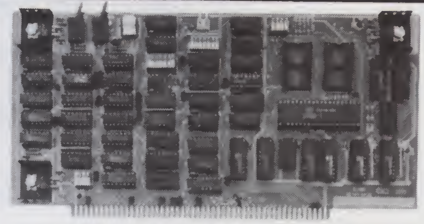
S-100 CPU



CB-2 Z-80 CPU - S.S.M.
2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.
CPU-30300K *Kit* $239.95
CPU-30300A *A & T* $299.95

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2/4 MHz Z-80A CPU with RS-232C serial I/O port and on-board MOSS 2.2 monitor PROM, front panel compatible.*
CPU-30400A *A & T* $269.95

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CPC-30200A *Jade A & T* $399.95

S-100 I/O

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	IBM Compatible (128 B/S, 26 sectors)	3060	2.19	5FD-111110	473071	53428	CM-F11	800506	2305830	40013	FD1-128	FD-1	740-0	S/A 100	15002	FD34-1000	F111111X	7870-K	421602
Flexible Disc 1s	IBM Compatible (128 B/S, 26 sectors) w/ W P N	3062	2.24	–	–	–	–	–	–	–	–	–	740-0	–	–	–	–	–	–
	IBM Compatible (128 B/S, 26 sectors) w/ W P N & Hub ring	3064	2.55	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Single Headed Drives	IBM Compatible (128 B/S, 26 sectors) REVERSIBLE	1729	3.35	5FD-113110	473072	54431	–	–	–	40015	–	FD-2	740/2-0	–	15150	FF34-2000	F171111X	7860-K	–
Single-Density Media	IBM System 6 Compatible	3066	2.19	–	473077	54561	–	800509	1669959	40014	–	–	740-0 066	–	15003	FD60-1000	F116111X	–	–
	IBM Compatible (256 B/S, 15 sectors)	3109	2.19	5FD-111210	473073	–	–	800884	2305845	40040	–	–	740-3600	–	15005	FD36-1000	F112111X	7861-K	–
	IBM Compatible (512 B/S, 8 sectors)	3110	2.19	–	473074	–	–	800585	1669954	40044	–	–	–	–	15004	FD60-1000	F113111X	7889-K	–
	Shugart Compatible, 32 hard sector	3015	2.19	5FD-211D10	470901	53802	CM-F21	101/1	–	40018	FH1-32	FD-132	740-32	S/A-1D1	15025	FD32-1000	–	7890-K	421322
	Shugart Compatible, 32 hard sector REVERSIBLE	3028	3.35	5FD-21301D	–	–	–	–	–	40017	–	–	74D/2-32	–	15151	FF32-2000	–	7880-K	–
	Wang Compatible, 32 hard sector w/Hub ring	3087	2.50	–	–	54491	–	–	–	–	–	–	740-32RM	–	–	–	F37A411X	–	–
	CPT 8000 Compatible	3045	2.79	–	–	–	–	–	–	–	–	–	–	–	15226	–	–	–	–
Flexible Disc 1d	IBM Compatible (128 B/S, 26 sectors)	3090	2.95	5FD-121010	474D71	54568	–	374D/1D	–	40047	FD1-128/M2100	FD-1D	741-0	–	–	FD34-8000	F131111X	7887-K	423002
	Soft Sector (128 B/S, 26 sectors) REVERSIBLE	3093	3.99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Single Headed Drives	Shugart Compatible, 32 hard sector	3091	2.95	5FD-221010	470801	54596	–	101/1D	–	40024	FH1-32D	–	741-32	S/A-103	15075	FD32-8000	F33A410X	7887-K	423322
Double-Density Media	Shugart Compatible, 32 hard sector REVERSIBLE	3094	3.99	–	–	–	–	–	–	–	–	–	–	–	–	–	F22A411X	–	–
	Wang Compatible, 32 hard sector w/Hub ring	3088	3.20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flexible Disc 2s	Soft Sector (Unformatted)	3101	3.84	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Soft Sector (128 B/S, 26 sectors)	3113	3.84	–	–	54428	–	800814	1766870	–	–	–	–	S/A-150	15153	FD10-4026	F121111X	–	–
Double-Headed Drives	Soft Sector (256 B/S, 15 sectors)	3106	3.84	–	473477	54226	–	800815	2736700	40043	FD2-256D	–	742-0	–	15154	FD10-4015	F122111X	7856-K	424612
Single-Density Media	32 Hard Sector	3108	3.84	–	–	–	–	–	–	–	FH2-32	–	–	–	–	–	–	–	–
Flexible Disc 2d	Soft Sector (Unformatted)	3102	3.49	–	473488	–	–	DY150	–	40028	FD2 XDM	FD-2D	743-0	–	15103	DD34-4001	–	–	425002
	Soft Sector (128 B/S, 26 sectors)	3115	3.49	–	–	–	–	–	–	–	–	–	–	S/A-150	–	–	–	–	–
Double Headed Drives	Soft Sector (256 B/S, 26 sectors)	3103	3.49	–	473471	54325	–	800817	1766872	40019	FD2-2560	–	743-0/256	–	15101	DD34-4D26	F144111X	7858-K	425602
Double Density Media	Soft Sector (512 B/S, 15 sectors)	3114	3.49	–	473472	54479	–	800818	1669044	40039	–	–	743-0/512	–	15100	DD34-4015	F145111X	–	425612
	Soft Sector (1024 B/S, 8 sectors)	3104	3.49	–	473473	54485	–	800819	1669045	40020	–	–	743-0/1024	–	15102	DD34-4008	F147111X	7859-K	425622
	32 Hard Sector	3105	3.49	5FD-321010	470651	–	–	101/2D	–	40021	FH2-32D	–	743-32	S/A-151	15125	DD32-4000	F34A411X	7861-K	425322
	Burroughs B-80 Compatible 32 Hard Sector	3092	3.49	–	–	–	–	–	–	–	–	–	–	–	–	–	F34A611X	–	–
	Soft Sector (1024 B/S, 8 sectors) w/ Hub Ring	3116	3.75	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flexible Disc FD Memorex 651 or Equiv Drive Compatible	FD VI (Vinyl Jacket)	30712003	2.95	–	470661	–	CM-F31	FDIV	–	40002	–	FD-165	S11-0	–	15026	FD65-1000	F81A111X	7610	–
Mini Flexible Disc 1s	Soft Sector (Unformatted)	3401	1.99	–	475001	54256	–	1D4/1	–	40500	MD1	MD 1	744-D	S/A-104	15300	MD525-D1	M11A211X	7897	441002
5¼" Single Headed Drives	10 Hard Sector	3403	1.99	–	475010	54257	–	107/1	–	40501	–	MD 11D	744-1D	S/A-1D7	15325	MD525-1D	M41A211X	7898	4411D2
Single-Density Media	16 Hard Sector	3405	1.99	–	475018	54258	–	105/1	–	40502	MH1	MD 116	744-16	S/A-105	15326	MD525-16	M81A211X	7899	441162
	Soft Sector (Unformatted) W/Hub Ring	3431	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-01	–	–	–
	10 Hard Sector w/Hub Ring	3433	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-10	–	–	–
	16 Hard Sector w/Hub Ring	3435	2.19	–	–	–	–	–	–	–	–	–	–	–	–	MD525-16	–	–	–
Mini Flexible Disc 1d	Soft Sector	3417	2.24	–	–	54848	–	104/1D	–	–	–	–	–	–	–	MD540-01	–	–	–
5¼" Single-Headed Drives	10 Hard Sector	3416	2.24	–	–	54849	–	107/1D	–	–	–	–	–	–	–	MD540-10	–	–	–
Double-Density Media	16 Hard Sector	3418	2.24	–	–	54852	–	106/1D	–	–	–	–	–	–	–	MD540-16	–	–	–
Mini Flexible Disc 2d	Soft Sector	3421	2.74	–	–	54824	–	104/2D	–	–	MD2-D	–	745-0	S/A-154	–	MD550-01	–	–	–
5¼ Double-Headed Drives	10 Hard Sector	3423	2.74	–	–	54827	–	107/2D	–	–	–	–	745-10	S/A-157	–	MD550-10	–	–	–
Double Density Media	16 Hard Sector	3425	2.74	–	–	54830	–	105/2D	–	–	MH2-D	–	745-16	S/A-155	–	MD550-16	–	–	–

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100 Percent Error Free
Each and every Memorex Flexible Disc is certified to be 100 percent error free. *Each* track of *each* flexible disc is tested, individually, to Memorex's stringent standards of excellence. They test signal amplitude, resolution, low-pass modulation, overwrite, missing pulse error and extra pulse error. They are torque-tested, and competitively tested on drives available *from al*most every major drive manufacturer in the industry including drives that Memorex manufacturers. Rigid quality audits are built into every step of the manufacturing process and stringent testing result in a standard of excellence that assures you, our customer, of a quality product designed for increased data reliability and consistent top performance.

Customer-Oriented Packaging
Memorex's commitment to excellence does not stop with a quality product. They are proud of their flexible discs and they package them with pride. Both their packaging and their labeling have been designed with your ease of identification and use in mind. The desk-top box containing ten discs is convenient for filing and storage. Both box labels and jacket labels provide full information on compatibility, density, sectoring, and record length. Envelopes with multi-language care and handling instructions and color-coded removable labels are included. A write-protect feature is available to provide data security.

Full One Year Warranty — Your Assurance of Quality
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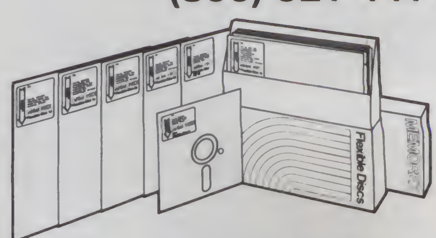

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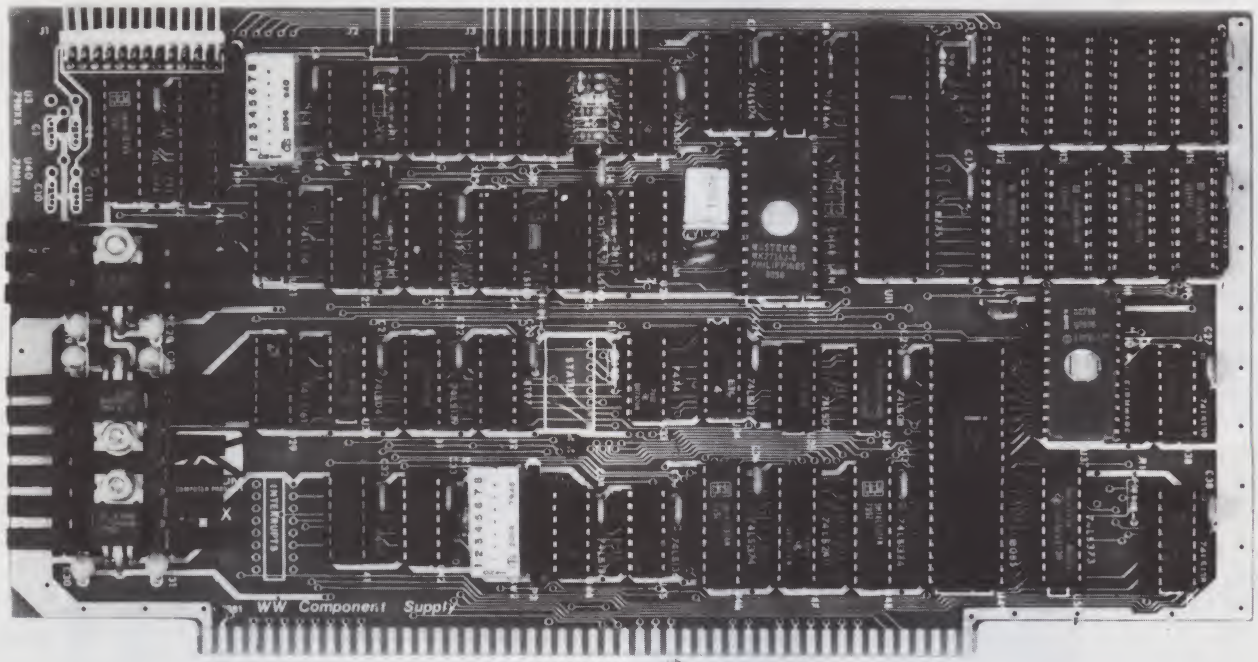
INTELLIGENT VIDEO I/O FOR S-100 BUS



VIO-X

The VIO-X Video I/O Interface for the S-100 bus provides features equal to most intelligent terminals both efficiently and economically. It allows the use of standard keyboards and CRT monitors in conjunction with existing hardware and software. It will operate with no additional overhead in S-100 systems regardless of processor or system speed.

Through the use of the Intel 8275 CRT controller with an onboard 8085 processor and 4k memory, the VIO-X interface operates independently of the host system and communicates via two ports, thus eliminating the need for host memory space. The screen display rate is effectively 80,000 baud.

The VIO-X1 provides an 80 character by 25 line format (24 lines plus status line) using a 5 × 7 character set in a 7 × 10 dot matrix to display the full upper and lower case ASCII alphanumeric 96 printable character set (including true descenders) with 32 special characters for escape and control characters. An optional 2732 character generator is available which allows an alternate 7 × 10 contiguous graphics character set.

The VIO-X2 also offers an 80 character by 25 line format but uses a 7 × 7 character set in a 9 × 10 dot matrix allowing high-resolution characters to be used. This model also includes expanded firmware for block mode editing and light pen location. Contiguous graphics characters are not supported.

Both models support a full set of control characters and escape sequences, including controls for video attributes, cursor location and positioning, cursor toggle, and scroll speed. An onboard Real Time Clock (RTC) is displayed in the status line and may be read or set from the host system. A checksum test is performed on power-up on the firmware EPROM.

Video attributes provided by the 8275 in the VIO-X include:

- FLASH CHARACTER
- INVERSE CHARACTER
- UNDERLINE CHARACTER or
- ALT. CHARACTER SET
- DIM CHARACTER

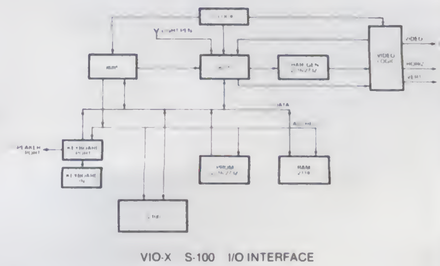
The above functions may be toggled together or separately.

The board may be addressed at any port pair in the IEEE 696 (S-100) host system. Status and data ports may be swapped if necessary. Inputs are provided for parallel keyboard and for light pen as well as an output for audio signalling. The interrupt structure is completely compatible with Digital Research's MP/M ®.

Additional features include:

- HIGH SPEED OPERATION
- PORT MAPPED IEEE S-100 INTERFACE
- FORWARD/REVERSE SCROLL or
- PROTECTED SCREEN FIELDS
- CONVERSATIONAL or BLOCK MODE (opt)
- INTERRUPT OPERATION
- CUSTOM CHARACTER SET
- CONTROL CHARACTERS
- ESCAPE CHARACTER COMMANDS
- INTELLIGENT TERMINAL EMULATION
- TWO PAGE SCREEN MEMORY

VIO-X1 – 80 × 25 5 ×7 A & T **$295.00**
Conversational Mode
VIO-X2 – 80 × 25 7 × 7 A & T **$345.00**
Conversational & Block Modes



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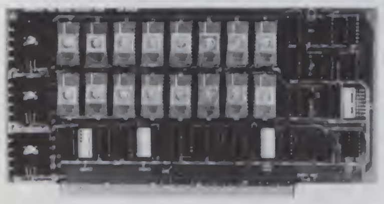

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Blank PC Board - $34

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9. Gold plated contact fingers.
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32K SS-50 RAM

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At Last! An affordable 32K Static RAM with full 6809 Capability.

FEATURES:
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6. Works with all existing 6800 SS50 systems.
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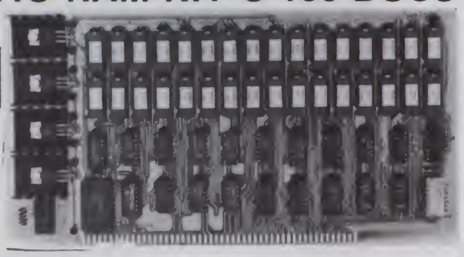

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6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
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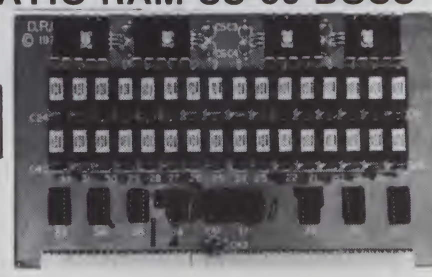

FOR SWTPC 6800 BUSS!

ASSEMBLED AND TESTED - $35

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2. Uses 2114 Static Ram
3. Fully Bypassed
4. Double sided PC Board. Solder mask and silk screened layout.
5. All Parts and Sockets included
6. Low Power: Under 1.5 Amps Typical

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TR1602B

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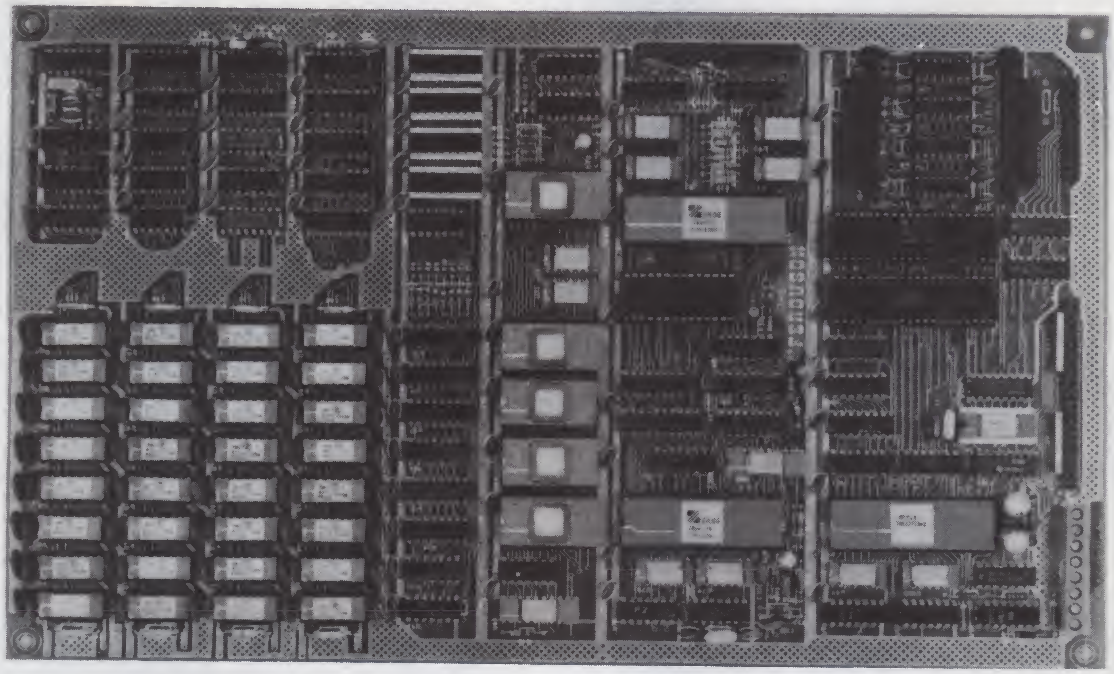

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SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
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64K RAM

Uses industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERUPTS. Fully buffered and runs 8080 software.

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Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232. For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: $85.

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S-100 Mother Board	45.00
SUB TOTAL	$1330.90

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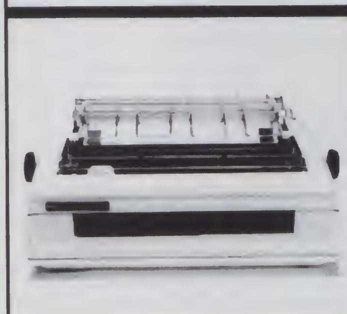

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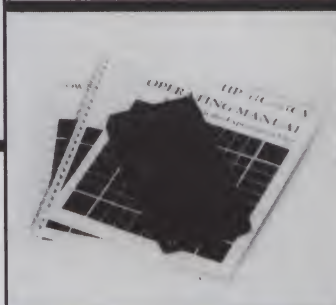

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LETTERS TO THE EDITOR

Force-feeding Education

The "Remarks" in the May 1981 issue caught my interest. I, too, have fond memories of high school and things have changed. I see this clearly since I taught mathematics on an intermediate and secondary level for the New York City Board of Education for two years. I am now teaching Computer Programming (BASIC, FORTRAN IV, and Pascal) to high school juniors and seniors.

You have outlined the problems in education well. The baby-sitting attitude in the public schools is abhorrent but true. I assure you, no one, teacher or otherwise, finds it particularly effective or rewarding to force people to learn.

We do have the responsibility of educating. This is especially important for those students who spend their most critical periods in grades one to 12. The question is how. I agree totally; the computer has come into education at a perfect time, but I maintain some intense reservations about computer-aided instruction which is teacher independent and home-based.

The unfortunate result of a student body separated and detached in the learning process would be the stunting of emotional and personal development. If the elements of interaction and communication are eliminated, the student may grow up feeling most comfortable only in front of a CRT.

I don't believe that the result would be more motivated children. Look back on your experiences in college. Although I am speaking about students whose age level is between six and 18, there is an analogy that can be drawn. What made the accounting course so uppermost in your mind? Where or from whom did the excitment come from? Was an honest concern about and interest in the students on the part of the teacher an ingredient in that positive experience?

I see a renaissance in education coming about. The advent of computer-aided instruction is responsible for this turning point. I am doing extensive research in this area and have implemented in-service workshops encouraging the use of computers not only in mathematics and science, but in languages (using speech synthesizing), history and English. Simulations and video disks will surely enhance and increase the amount of information retained by the student. Some other techniques will involve "live" photos and accurate graphics, along with background music and professional voice over-dubbing.

All in all, we should not force education.

Moving the students out of the schools will not ensure better behavior in society; it may only postpone and augment the problems in the long run. I firmly believe this, even after being assaulted twice in the public schools. Finally, with human example and intervention, these situations can be encountered and averted as soon as possible. The choice rests on a joint, concerted effort, on the part of the parents and schools.

One thing is for certain. With CAI, further developed systems, and more teachers involved in this progress, the renaissance in education is coming of age, regardless of how much time it will take, or the pain in the undertaking. That is why I foresee better schools, more effective teachers, and a raised level of learning. I am looking forward to the advances to be made by both teachers and Instant Software.

Paul S. Drago
St. Raymond High School for Boys
Bronx, NY

Wayne Green Replies

Your argument has merely proven my point.

The teacher I had for accounting had showmanship. We didn't really get to talk with him much or ask questions . . . it was all enthusiasm on his part and excitement. I find a similar enthusiasm from shows such as Connections, Freedom to Choose, etc. If we can get exciting people to put this stuff on video, using computers to match the speed of the teaching to the interest and intellect of the student, I think we would have a winner.

Your letter was most interesting. It's good to hear from the trenches.

Wayne Green

Inexpensive Word Processing

Craig Anderton ("In Search of the Processed Word," May 1981, p. 39) leaves the impression that a sophisticated word processing system, such as his, must cost at least $10,000. Not so. Couple the new Osborne I, including its double density option, with one of several daisywheel printers selling for under $2000, and you have a roughly comparable system, including the same software, for under $4000.

I'm writing this letter on a used TRS-80 Mod I with Radio Shack's Daisywheel II printer operating under Scripsit enhanced with Acorn's Superscript. The cost is again under $4000, including disk drives. I suspect professionally useful word processing systems need no longer be as prohibitively expensive as Mr. Anderton's.

Stan Franklin
Memphis, TN

Response:

Your claim that a $4000 Osborne-based system is equivalent to the system described in the article is stretching things. The Osborne can't do multi-user tasks (which mine has to, on occasion), nor is it easily expandable (I've upgraded my system several times since the article was written).

Craig Anderton
Redwood Valley, CA

Osborne the Obnoxious?

If "it was inevitable" that the Osborne I microcomputer would become a reality, I suppose it was also inevitable that the product introduction would be accompanied by a torrent of the usual self-righteous pomposity from Adam Osborne. Clearly, Osborne has every right to hype his micro-screened computer, but why does he make your readers suffer through a diatribe against the rest of the industry before getting to the system's features? Are we expected to buy an Osborne I because it can do something *better* than other systems on the market, or as simply a vote of support for the manufacturer's imagined "mandate"? Such "crust" deserves an award, but I haven't yet decided whether Mr. Osborne's complexion is better suited to a raspberry or a lemon pie!

Jack Carlson
Anaheim, CA

Osborne makes good reading. However, there is more to say about the Osborne I microcomputer than appears in the May 1981 issue of *Microcomputing*.

In size and weight the Osborne I is more similar to a portable sewing machine than to a briefcase. A more attractive package would be something like the HP-85 with a couple of the new Sony 3-1/2 inch floppy disk drives.

An 80-column external monitor will not be available for the Osborne I, but rather for a subsequent Osborne model.

Although Osborne touts compatibility and excoriates other manufacturers for their unique hardware and software designs, the Osborne I has its own hardware incompatibilities. The video output will not drive the standard monitor: you must

buy a unique Osborne monitor if you want a larger external display. The Osborne I printer interface is standard RS-232 (serial) or standard IEEE-488 (parallel). RS-232 is fine for expensive letter-quality printers but the standard microcomputer printer is a low-cost unit with a Centronics-compatible (not IEEE-488) parallel interface. The Centronics-compatible parallel interface has become the de facto standard microcomputer printer interface. IEEE-488 is an expensive parallel interface used primarily by industry in multiple instrument, control/measurement systems. Osborne espouses low cost hardware; he should have awarded himself a true White Elephant award for that IEEE-488 interface.

Other than that it looks like a good deal.

Robert C. Briggs
Mountain View, CA

The Letters Pour In

We are receiving a colossal number of letters from people who read my article in your magazine (May 1981). They are coming in at the rate of ten to 20 per day. That beats anything generated by publicity in any other magazine.

Adam Osborne
Hayward, CA

What else did you expect?—Editors.

More on CBASIC2

I'd like to make the following comments on the review of CBASIC2 by Bruce Evans in the May 1981 issue of *Microcomputing* (p. 254).

1. I agree with and wish to emphasize his comments about CP/M's ED editor. It is absolutely the worst I have ever used, and I have used several.

2. Evans must have never seen Microsoft BASIC, if he thinks CBASIC2 is the most extensive version of BASIC. Their BASIC 80 is at least as extensive (but it sure chews up a chunk of core).

3. Let me put one false statement to rest here and now. CBASIC2 *does not run faster than the usual BASICs!* The interpreter running on my TRS-80 Model I is faster! CBASIC2 is very slow, due to the fact (as Mr. Evans states) that it is not a true compiler. If you want to see a really fast BASIC, try Microsoft's BASIC Compiler. It also has the advantage that you can run your software on the interpreter first to remove *all* the bugs before compiling *one time.*

4. His comments about string manipulations are true, except for one problem. There is a MID$ function to pull pieces of strings out, so that these can be converted to real variables, but there is no easy way to reverse the process. That is, you cannot easily put real variables in the middle of a string.

Just as a side note, there is a version of CP/M and CBASIC2 available for the TRS-80 Model I. I know. . . I bought it. Only after this did I realize that there is no way you can effectively utilize it on this machine with 5-1/4 inch 35/40 track single density drives. CP/M and CBASIC2 require eight-inch drives with their resultant capacity, or double density small drives.

Charles Reeves, Jr.
Union Carbide
Oak Ridge, TN

Response:

I agree with Mr. Reeves's second point—Microsoft's BASIC-80 is very extensive. But it is also very expensive—almost three times as much as CBASIC2. I also agree with Mr. Reeves that BASIC-80, being an interpreter, chews up a lot of computer memory.

It is on point three that we differ. I must admit that when I went back to the benchmark programs in October 1977 *Kilobaud*, CBASIC2 took a bath on the simple programs. However, by the time I got to program four, CBASIC2 had quite an advantage over my older Processor Technology Extended Cassette BASIC and over my Micropolis Disk BASIC. In using these benchmark tests, there is some problem in deciding when to start timing. Previously, I had started the stopwatch when I pressed RETURN after typing RUN, but this is not valid with a CBASIC2 program, since after you enter "CRUN2 'filename' ", you must wait while the run time interpreter is loaded, the program is loaded and the execution begun. This time overhead is ridiculous for a short benchmark program, but it is negligible for one that will run for hours.

Mr. Reeves's comments on Microsoft's BASIC Compiler are a little misleading. To write, run and debug your software on the interpreter and then compile it with the BASIC Compiler, you must have both sets of software, each of which costs over $300. Mr. Reeves needs almost $700 worth of software to do what CBASIC2 can handle for less than $100. I shall put up with these slight limitations unless Mr. Reeves or Microsoft is willing to send me a complimentary copy of BASIC-80 and their BASIC Compiler!

Mr. Reeves's fourth point is correct. I had not yet run into this problem. It can be programmed around by using the LEFT$ and RIGHT$ functions to split the original variable into two separate ones. Create the new string by concatenating the third string variable between these two strings. I agree this is a nuisance but it is not insurmountable.

Mr. Reeves's "side note" only strengthens my belief that "toy" microcomputers have no place in business. I use a SOL-20 with a dual drive quad density Micropolis disk system. Each disk uses 77 tracks and can store 350K of data. For the same reason, I am typing this letter by hand—the inexpensive letter-quality printers cannot handle business applications and I cannot yet cost-justify a "professional" daisywheel!

Bruce Evans, M.D.
Pickering, Ontario
Canada

Business Applications

Please accept my congratulations and best wishes for success in your new undertaking, *Desktop Computing.*

Martin Klaver, writing the June Perspectives, explained the problem beautifully—we need microcomputers for micro applications—and we need to be able to learn to use them quickly.

I have had an Apple II for about six months and have been trying to use it in connection with a real estate and related investment business. As a computer beginner, I'm having problems and I need help.

Please sign me up for *Desktop Computing.*

David S. Ailes
Winter Park, FL

No Longer Undocumented

Edwin Freed's article about "secret" Z-80 codes (April 1981, p. 58) was both interesting and instructive. Although the additional codes do not promise to revolutionize Z-80 programming, they may indeed be handy at times.

Tests run on my TRS-80 entirely confirm the accuracy of Mr. Freed's statements. He does not, however, deal specifically with one group of codes: the four-byte codes starting with DDCB or FDCB. The 62 documented codes in this group perform rotations, shifts and bit operations upon memory locations indicated by the IX or IY registers as offset by the value specified in the third byte of the code. The undocumented codes similarly use the IX or IY registers, with offest, as pointers to the memory locations affected, but, with the exception of the BIT instructions, they also load the results into a register.

For example, the code DDCB05C8 will set bit 1 of the memory location whose address is five greater than the contents of the IX register and will also load the resulting value into the B register. For this operation, which would normally require two separate instructions, I use the mnemonic BSET 1,(IX + 5), the letter B indicating the register loaded.

The specific operations and the registers loaded by these codes may be determined readily by comparing the second and fourth bytes with the regular two-byte CB codes. Only in the case of the BIT operations is the indicated register left unloaded; thus the undocumented codes whose fourth byte is between 40 and 7F merely duplicate existing codes.

Even the RLO operation described by Freed is available: the code FDCB0937 (ARLO (IY + 09)) rotates the byte indicated by IY + 9 to the left, shifts a 1 into the low-order bit, and loads the result into the A register. Note that it would normally take three instructions to accomplish this result.

James Yowell Yelvington
Stillwater, OK

Califorina Dreaming

Here is one of those "I have never written a letter to the editor (all right, publisher) before" letters. This time I cannot restrain myself.

I have just finished reading Wayne Green's comments in the June issue. As one of the old-time followers (more than five years), I am distressed to hear of the poor showing that this industry is accused of giving. Sure, I was at the Faire and saw all that you saw but I ask you—is it fair to judge our entire industry on the basis of this small coterie of 32,000 isolated individuals?

No matter, I see further on that there is a serious article on the solid businesslike business of multitask systems. This will show them we have our act together! OOPS! As I peruse the lead photos of these two heavy duty and surely deadly serious computers I see screened right on the front panel that Action Computer Enterprise, Inc., believes that they are located in Pasadena, Califorina . . . CALIFORINA?

I hope that the article is great. I still can't read it through the tears in my eyes. Please, Lord, tell me that this is just the act of some misguided graphic artist retouching the print for greater clarity.

David Geo. Krauss
Menlo Park, CA

These are limited edition models. Act now while the supply lasts. Guaranteed to become a collector's item.—Editors

Passing the Buck

Recently I faced a problem using a C. Itoh 25 cps Starwriter with a California Computer Systems (CCS) Centronics parallel interface, and the Apple PIE Word Processor by Programma. It seems the customary control-I 80N command that was needed couldn't be entered except as text in the program.

To make a long story short, the driver program that was supplied with the CCS interface didn't cooperate with the C. Itoh printer. Talking to CCS put blame onto Apple PIE and C. Itoh; talking to Programma put blame onto CCS and C. Itoh; and, you guessed it, talking to C. Itoh put blame onto CCS and Apple PIE.

The solution to this problem is so fundamentally simple that it only needs nine bytes instead of the usual 256 bytes for a driver. It involves storing the accumulator into the appropriate data address for that slot ($C0n0, where n = slot + 8), loading the accumulator from the same address and then when the value is no longer the same, to return for the next character.

The program in Listing 1 is relocatable not only pagewise but wherever you have nine bytes to spare.

You can even take this one step further by replacing the 5623 PROMs that the CCS board has with a pair of 2112s (256 byte by four bit RAM). Just remember which 5623 is the high order and which is the low order so if you replace them the board will function properly.

A program like Apple PIE asks, by way of a SYSGEN Program, for the printer driver starting address. A slot number will automatically generate a $Cn00, where n = slot number. You may assign this to any address in memory if you desire. If you install the RAMs then you would just BLOAD the driver into the $Cn00 address. If not, then the proverbial $300 is always there.

Mark Johnson
Schultz Systems, Inc.
Barnegat, NJ

```
]PRINTCHR$(9);"80N"


]CALL-151

*300L

0300-   8D A0 C0    STA   $C0A0
0303-   AD A0 C0    LDA   $C0A0
0306-   30 FB       BMI   $0303
0308-   60          RTS
0309-   00          BRK
030A-   00          BRK
030B-   00          BRK
030C-   00          BRK
030D-   00          BRK
030E-   00          BRK
030F-   00          BRK
0310-   00          BRK
0311-   00          BRK
0312-   00          BRK
0313-   00          BRK
0314-   00          BRK
0315-   00          BRK
0316-   00          BRK
0317-   00          BRK
0318-   00          BRK
*D4F2G

]

]C0A0 IS THE APPROPRIATE DATA ADDRESS FOR SLOT # 2
```

Listing 1.

A Different Approach

I have a few comments to add to the "North Star Quiz" which was in the June issue. I approached the problem of the exclamation point and PRINT commands differently, by modifying the command table in the BASIC itself. By changing the code for the exclamation point command from 146 to 130, when new programs are typed both the exclamation point and PRINT are stored as the same code and will therefore be listed as PRINT. However, to properly list a previous program which used the original 146 code, it has to remain in the command table unchanged also. For this patch to work properly, the PRINT must be first, the changed exclamation point second and the unchanged exclamation point last. They don't have to be the first three entries in the table, nor do they have to be adjacent, but they should be in this order. Since other data follows this table its size can't be changed.

I gained the extra two bytes by reducing SQRT to SQR and FREE to FRE. Looking over the table again I see that a better possibility would be to delete the square bracket. The only purpose of this in the table is to automatically convert an open bracket to an open parenthesis. Incidentally, Mr. Prisco left the FREE command out of his list; it is 216 decimal or D8 hex.

The command table starts at 3B65 hex or 15205 decimal in the single-density release four version. I don't know about the other versions, but it is easy to find by using an ASCII dump routine such as the DA command in the North Star Monitor program. The code byte precedes each string.

About the only problem with this change is that an exclamation point in a REMark is also expanded to PRINT. This doesn't affect the running of the program, but it sure lists funny. Actually, Mr. Prisco's programs would do the same thing, but they could be rewritten easily to check for the REM code to ignore the rest of the line.

Another change that I made to the command table was to change EXAM and FILL to PEEK and POKE. There is no real advantage to this, but it gives some strange effects when listing a program that was entered without this patch. For example, the phrase FOR EXAMPLE comes out FOR PEEKPLE.

Larry Hudson
Ventura, CA

"If Superman isn't around, we'll be meeting our maker in 4.956 seconds."

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Desktop Computer and Word Processing System

A 64K desktop workstation that can be used as a word processing system, a business computer or both is available from Xerox Corporation, Office Products Division, 1341 West Mockingbird Lane, Dallas, TX 75247. The Xerox 820 can also be connected to the company's Ethernet local area communications network, which links different kinds of office equipment for high-speed exchange of information. As a word processor, the 820 is designed for organizations needing low-cost display systems. As a desktop computer, it is intended for small businesses and for professionals and managers in larger organizations. Appropriate software tailors the equipment for either function.

The system's standard disk storage has a capacity of about 45 pages of text. A larger disk unit, with a storage capacity of about 140 pages, is available as an option. The printer is a daisywheel Diablo 630, which prints bidirectionally at up to 40 characters per second. Xerox will provide the industry-compatible operating system software for the 820. Price of the desktop computer version, including display screen, keyboard and standard disk storage, is $2995. As a word processing system, with the optional 40-cps daisywheel printer, price is $5895. Software is priced separately. Reader Service number 489.

Xerox 820 information processor.

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The SLC-II is a serial line controller that combines microprocessor intelligence with voice synthesis capability. The SLC-II can automatically dial phone lines and talk in its electronically synthesized voice. Its vocabulary includes more than 300 words, the alphabet and numbers. The SLC-II will spell what it can't say. No software changes to the host computer's operating system are needed. The SLC-II connects between any computer and terminal to monitor the flow of messages. It can then be taught to initiate voice messages at specific time intervals—or upon recognition of certain messages moving from computer to terminal. The SLC-II can also listen and respond to incoming phone messages that originate at a remote terminal or are generated by a telephone keypad.

The SLC-II features automatic time and date entry with a day/month/year calendar. It also comes with built-in power backup via rechargeable batteries, an auto-dial/auto-answer modem, and 16K, 32K or 80K RAM. Priced at $1975. Reader Service number 486.

Digital Pathways, Inc., 1260 L'Avenida, Mountain View, CA 94043.

A telephone-based terminal operator from Digital Pathways.

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An attractive and practical microcomputer cabinet is available from Instructional Development Systems, 2927 Virginia Beach Blvd., Virginia Beach, VA 23452. Compatible systems include Apple II, Atari, Texas Instruments 99/4, Ohio Scientific, Sorcerer and other modular systems. The wood door provides maximum equipment security with two solid brass locks and a full piano hinge; the door opens to serve as a work table. The microprocessor and disk drive units slide out on tray rollers, providing easy access to components. Adequate space is provided for most 13-inch televisions or monitors; monitors are angled down for maximum screen visibility. The design of the cabinet assures a distance of approximately 24 inches from the user's eyes to the television screen, reducing the danger of radiation exposure, eye strain and fatigue.

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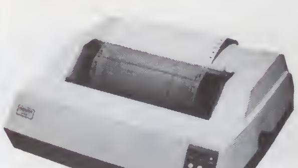

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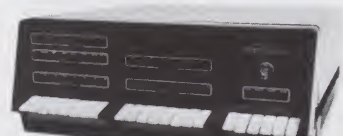

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disks, or one storage compartment can be used to house a small line printer. The cabinet is solid wood with a formica veneer. Convection venting is included to cool system components. The cabinet comes fully assembled and ready to use. Priced at $275. Reader Service number 485.

Letter-Quality Printer

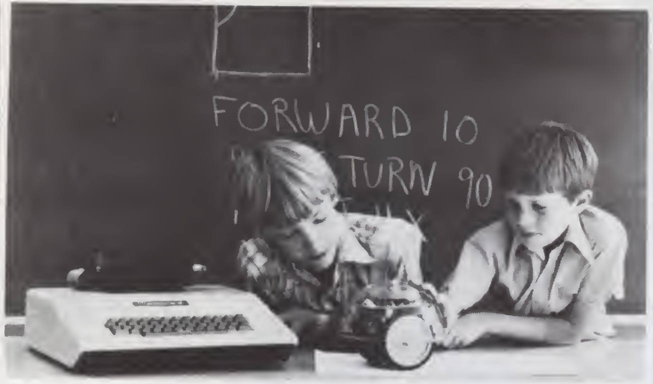
The Sprint 9 letter-quality daisywheel printer, from Data Wholesale Corp., 700 Whitney St., San Leandro, CA 94577, now offers an improved carriage drive mechanism. The micro-drive Kevlar belt enhances print quality and registration, and also makes steel carriage cables, pulleys and excessive service adjustments obsolete. The Sprint 9 has fewer parts, making it easier to service than previous Sprint products. The top cover has been totally redesigned for easier carriage assembly access. The printer also features acoustic sound reduction, an internal power supply and new quick-load ribbons.

Sprint 9 is available with two different RO front panel configurations, limited or complete front panels, at either 45 or 55 cps. The Sprint 9/45 is $2455 ($100 less for a limited front panel); the 9/55 is $2555 ($100 less for limited front panel). Reader Service number 484.

Interface with a Turtle

Terrapin, Inc., 678 Massachusetts Ave., #205, Cambridge, MA 02139, now has a smart Terrapin-Apple interface for its robot, the Turtle. The interface lets the user control the Turtle from a high-level language (BASIC, Pascal, Logo) via simple I/O statements. It can be used at home or in the classroom for teaching, learning or just having fun. The smart interface includes a parallel port, a

Sprint 9 letter-quality printer from Data Wholesale.



The Terrapin Turtle can now be interfaced to an Apple microcomputer.

separate regulated current-limited power supply and interface software. The parallel port I/O card contains the interface software in ROM, and plugs into one of the Apple's peripheral interface connectors. The program in ROM initializes the I/O port, generates the appropriate bit pattern for a specific command, compares this with the previous command byte to determine which bits must be left on, and writes to the appropriate output port location. The interface software allows Turtle control commands to be sent directly to the Turtle. The assembled Terrapin Turtle costs $599.95; kits are $399.95. Interfaces are $199.95. Reader Service number 493.

Biofeedback

The Biocom is a new peripheral from Total Digital Engineering, 210 Daniel Webster Highway, S. Nashua, NH 03060. Biocom measures your galvanic skin response (GSR) using two Velcro wrappers for your fingers (or one from each person at the end of a circle of people holding hands). The user selects sample rate, sensitivity and how the readings are to be processed and presented. The readings are transmitted to your microcomputer, where, with the appropriate software, the readings will produce a GSR plot or act as a relaxation trainer, a computerized Ouija, a lie detector or a personal growth system.

Biocom is easily tied into your computer via an asynchronous RS-232 port. Software is supplied as BASIC listings, annotated to point out differences in the interpreters of different microcomputers. You can also buy software on cassette or diskette for $15. The Biocom, with manual, listings and personal growth booklet, is $125. Reader Service number 492.

Design Tool

The Pencil Box logic designer is a portable breadboarding instrument for designing logic circuits and includes an I/O port for microcomputer experiments. The

The Biocom biofeedback peripheral from Total Digital Engineering.

✓See List of Advertisers on page 194

The Pencil Box from E & L Instruments.

Pencil Box incorporates major design needs in a molded plastic case with an integral hinged cover. It features a variable clock, two pulsers, eight LED readouts which also serve as a latched output port, eight logic-level switches which also serve as an input port and E & L SK-10 solderless breadboarding socket. Power is supplied by four 1.5 V batteries or an optional ac adapter. A Zener diode reduces the input voltage to 5 V for standard TTL work. The Pencil Box, assembled, is priced at $99.50; kit is $75.

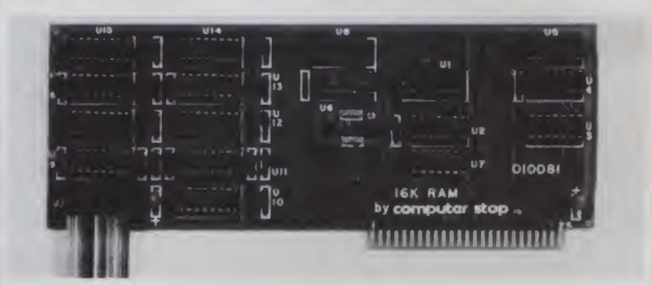
E & L Instruments, Inc., 61 First St., Derby, CT 06418. Reader Service number 491.

RAM Card for Apple II

Computer Stop, 2545 W. 237th St., Suite L, Torrance, CA 90505, is offering the CS16K RAM card to increase Apple II memory. With 48K of RAM already in place, this new card increases capacity to 64K. This RAM is computer-designed, using the shortest distance between points and laying heavy traces that improve overall reliability. It is compatible with Pascal, CP/M, DOS 3.3, COBOL, FORTRAN, VisiCalc, PILOT, Integer BASIC, Applesoft BASIC and other software currently used with Apple II. This additional 16K RAM lets you run the 56K CP/M operating system, increases buffer storage for word processing and VisiCalc or other calculation programs, and lets you run with FORTRAN and other high-level programming languages. It is priced at $195. Reader service number 499.

Z-80 Processor Board

The CPC-2810 Z-80 processor board is now being offered by Systems Group, a division of Measurement Systems and Controls, Inc., 1601 Orangewood, Orange, CA 92668. The board is designed specifically



Computer Stop's CS16K RAM card.

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Full Screen Mapping for CCA DMS	59
Pascal Interactive Terminal Software (PITS)	29
Basic Interactive Terminal Software (BITS)	29
Data Capture	29
Data Factory DMS	95
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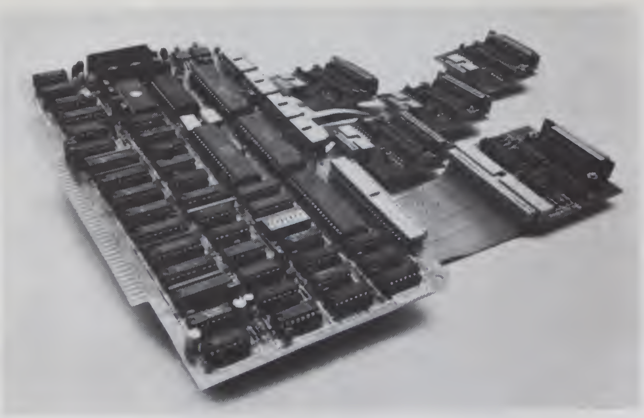


Systems Group Z-80 processor board.

for the S-100 bus, and is compatible with single-user, multi-user or networking systems. It features two or four serial I/O channels, software-selectable baud rates, two parallel I/O channels and eight vectorized, prioritized interrupts. The price is $495. Reader service number 498.

Increase H/Z-89 Storage to 7.6 Megabytes

A new double-density disk controller for the Heath/Zenith-89 computer supports up to four eight-inch disk drives and four five-inch drives. These supplement the three five-inch drives supported by the existing Heath/Zenith controller. The new controller increases on-line access to 7.6M. It can handle any combination of industry-standard eight-inch drives and five-inch 40-track or 80-track drives in either single- or double-sided versions. The controller is priced at $595, including CP/M 2.2 on either five-inch or eight-inch media.

Magnolia Microsystems, Inc., 2812 Thorndyke Ave., West, Seattle, WA 98199. Reader Service number 497.

Disk Storage for TRS-80 Model III

The Disk III, offered by VR Data, 777 Henderson Blvd., N-6, Folcroft Industrial Park, Folcroft, PA 19032, is a 5-1/4 inch disk storage subsystem for the Radio Shack TRS-80 Model III computer. It is fully compatible with the Model III hardware and software. The Disk III is calibrated, aligned, tested and burned-in prior to shipping. It can be installed by VR Data, or can be easily installed by any mechanically inclined person with simple hand tools. The Disk III basic unit consists of controller, power supply, mounting bracket, one 40-track (6 ms) disk drive and associated cabling. Price is $599. Reader Service number 495.

VR Data's Disk III.

Archives III word processor/computer.

Static 64K RAM Uses 100 ns Chip

Seattle Computer Products, 1114 Industry Drive, Seattle, WA 98188, recently announced their SCP-110, a 64K IEEE S-100 memory card. It uses the 100 ns Intel 2167 16K static chip. The new chip allows memory management functions of offset and protection to be performed with the firm's 8 MHz 8086 CPU without a wait state. The card performs both eight-bit and 16-bit transfers, switching automatically. The chips are used in a power-down mode to minimize current. Power requirement for an active board is 1.6 A at 8 V, while an inactive card uses 0.8 A. The card uses 24-bit addressing; the upper eight can be disabled. Price is $1295. Reader Service number 487.

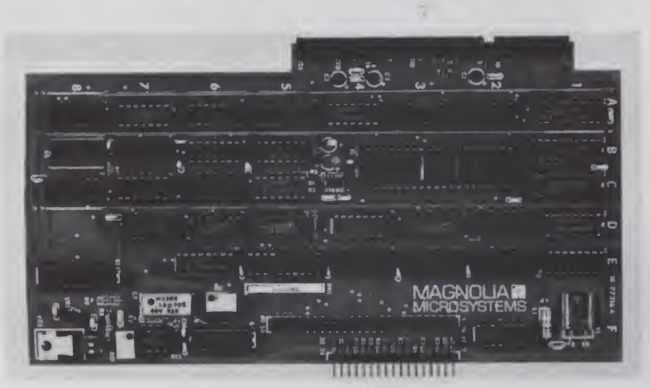
More Available Memory

The Archives III word processor/computer offers greater storage capacity than previous models. The Archives III features a Tandon double-sided disk drive and a Seagate 5M 5-1/4 inch Winchester disk drive. Total storage will be 5.75M. The unit is priced at $8500.

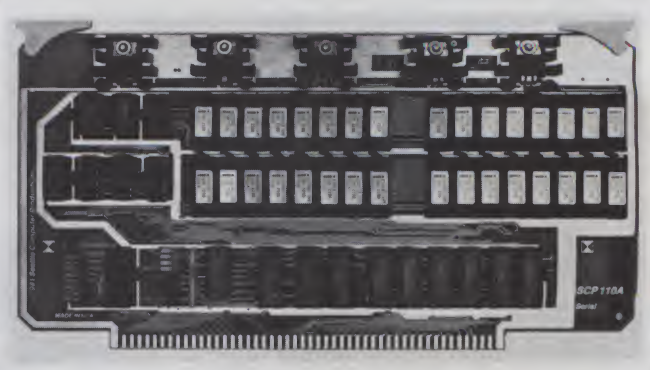
Archives Inc., 404 West 35th St., Davenport, IA 52806. Reader Service number 494.

Touch-Sensitive Add-On for Lear Siegler Terminal

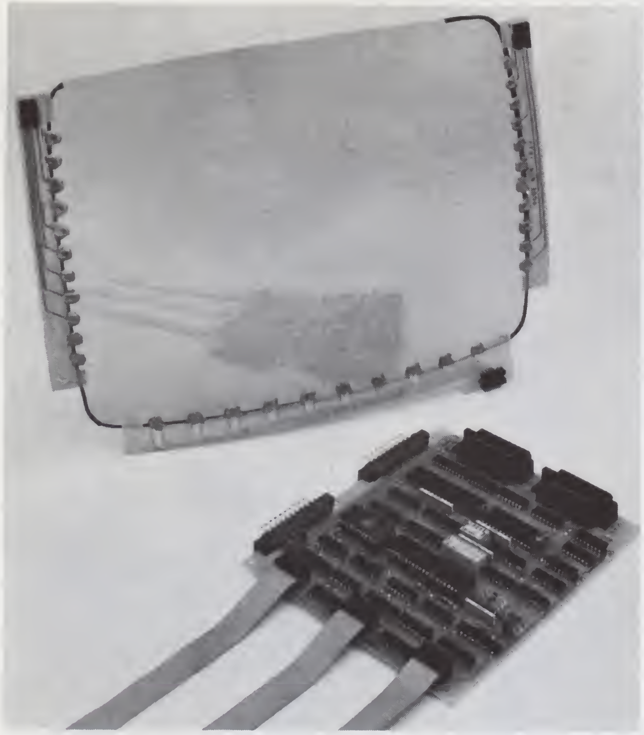
Interaction Systems, Inc., 24 Munroe St., Newtonville,



Double-density disk controller from Magnolia Microsystems.



Static RAM card from Seattle Computer Products.



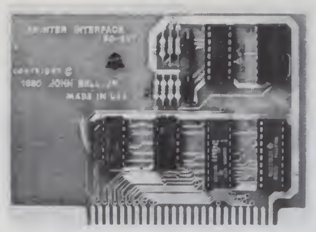
Interaction Systems' TK-242 touch-sensitive add-on kit for the ADM-42.

MA 02160, is offering its Model TK-242 touch-sensitive add-on kit, designed for use with the Lear Siegler ADM-42 CRT terminal. The kit provides the video display terminal with a human interface that is easy to use. The touch-sensitive feature lets the terminal respond to the touch of the finger on data displayed on the CRT screen. The kit consists of a glass touch-sensitive faceplate that overlays the terminal's CRT monitor, an electronics board and mounting bracket which fit inside the CRT monitor housing and interconnecting cables and mounting clamps. The price is $995. Reader Service number 496.

Apple-Compatible Printer

IMP2-Apple, a low-cost impact printer designed to operate with Apple microcomputers, is being offered by Axiom Corporation, 5932 San Fernando Road, Glendale, CA 91202. IMP2-Apple is equipped with both friction and tractor feed. This versatile printer enhances the Apple's capabilities by providing extra features, such as lowercase

Axiom IMP2-Apple printer.



Printer interface from John Bell Engineering.

characters. IMP2-Apple is compatible with Pascal. It is priced at $895. Reader Service number 490.

Parallel Printer Interface

John Bell Engineering, 700 Warrington Ave., Redwood City, CA 94063, is announcing a parallel printer interface to interface your Apple II microcomputer to Centronics-compatible printers. This board features on-board ROM compatible with Applesoft and Integer BASIC (Pascal disk available separately), has all the commands of the Apple printer interface and has an additional command for graphics. The price is $79.95, assembled and tested, or $69.95 for the kit. Reader Service number 464.

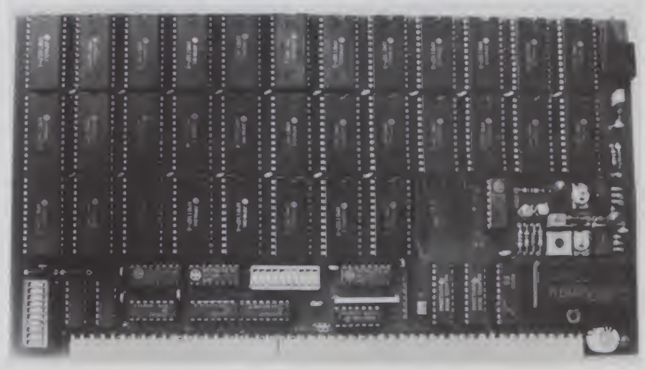
Super Expansion Board for OSI

The Super Expansion Board (SEB) is a high resolution color graphics/memory expansion board for the Ohio Scientific Superboard II/Challenger 1P computers. The SEB incorporates the following features on a 10 × 12-inch board: 16K memory expansion, 11 software-selectable display modes with graphics resolution of up to 256 × 192, up to eight user-selectable colors, 6K display memory and eight-bit parallel port with handshake. The SEB is designed to mount/connect directly to the computer without any user modifications. It is available assembled and tested for $249, or as a bare board with documentation for $59. Grafix, 911 Columbia Ave., N. Bergen, NJ 07047. Reader Service number 465.

RAM Board with Backup Power Supply

Gimix, Inc., 1337 West 37th Place, Chicago, IL 60609, announces their new 64K CMOS static RAM board with battery backup for the SS50/C bus. This board is compatible with any of the 6800/6809 DMA techniques. They are guaranteed for 2 MHz operation with no wait states or clock stretching required. Low power CMOS RAM requires 250 mA at 8 V for a fully-populated 64K board. It is nonvolatile, using an on-board nickel-cadmium battery. The board retains data even with system power removed. With the battery fully charged, the contents of the memory remain intact for a minimum of 21 days.

The Gimix board is priced at $1088.64. Reader Service number 488.



A new static RAM board from Gimix, Inc.

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Edited by Linda Stephenson

CP/M Disk Catalog
Model III Development System
Apple Accounting and Data Management
Pascal Billing System
TRS-80 Voice Synthesizer

CP/M Disk Catalog System

Master Disk Catalog comprises three assembly-language programs for CP/M-based systems. This system will maintain a record of the files from your disks on a single catalog disk. Comments and dates which you have inserted in programs can also be recorded on the catalog disk. It will locate a particular document in word processing applications, and help you keep track of data files or the various stages of program development. The disk catalog can be searched for all occurrences of particular file names, for text in your comments or for dates. File names and disk names can include CP/M wildcard characters.

Master Disk Catalog is available on single-density eight-inch disk for $35.

Mendocino Software, PO Box 1564, Willits, CA 95490. Reader Service number 483.

PDS for TRS-80

The PDS assembly-language development system is now fully operational under TRSDOS for the Radio Shack TRS-80 Model III computer. PDS includes a relocating macro assembler, linkage editor/linking loader, string-oriented text editor, interactive editor/assembler, trace debug/monitor, disk disassembler and several utilities which extend the power of TRSDOS. The relocating macro assembler and linkage editor support modular program development: large programs can be developed in independent, easily manageable segments which can be linked together for execution. Program segments can be chained together at the source level or linked together at object level. Commonly used program segments, once assembled, can be used thereafter without reassembly. Extensive conditional arithmetic and string operations let you develop sophisticated macro libraries to create a high-level macro language or to cross assemble programs for any of the commonly available processors.

Program modules can be modified, assembled and checked in seconds with the interactive editor/assembler. Debugging is aided by single-step trace capability, with full display of registers, flag status and the mnemonics of the instruction just executed and the next instruction to be executed. Both assemblers use an extension of the Intel instruction set. The PDS development system is available on five-inch double-density disk with documentation for $99.

Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107. Reader Service number 471.

Apple Accounting Module

Systems Plus, 3975 East Bayshore, Palo Alto, CA 94303, is introducing an additional module to the Apple Accounting Plus II software package. An inventory module with purchasing brings the total number of modules available to four, including General Ledger, Accounts Receivable, Accounts Payable and now Inventory with Purchasing. The inventory-purchasing module is integrated with General Ledger. It supports four different costing methods—Standard, Weighted Average, Lifo and Fifo. It also maintains a master parts list, offers eight-character alphanumeric part identification and 100 product groups. The module prints purchase orders and maintains on-order quantities, and it supports inventory to allow for receipts, issues and adjustments. It maintains a complete audit trail of all inventory transactions for the current month.

The inventory-purchasing module generates full inventory reporting. Reader Service number 470.

Overland Role-Playing Game

A new EPYX role-playing fantasy is available from Automated Simulations, Inc., PO Box 4247, Mountain View, CA 94040. The player has 21 game days (about half an hour playing time) to find the Dragon's Eye, a magical jewel hidden somewhere in one of seven provinces. He chooses his role from 16 characters, each with a unique set of magical abilities—healing, flying, time travel, teleport. He takes his choice of four swords, bow and arrow or magic bolt. The

screen displays a detailed map of the provinces and the location, strength and health of the character. When a monster is encountered, animated battle graphics display the action between player and beast. The player must confront dragons, bats, vampires, ghosts, golems, serpents, skeletons and other adversaries. He can fight with sword or bow, or cast a magic spell.

The Dragon's Eye on cassette for the PET (32K) or on disk for the Apple (48K, Applesoft in ROM) is $24.95. Reader Service number 468.

Data Management For the Apple

ESP dataKEYper is a data management system for the experienced data processor or the beginner who does occasional programming. It is menu-driven and tutorial. The system creates, changes, searches, sorts and lists data files. Its screen formatting flexibility lets you tailor the input screen definition to suit your application. The dataKEYper then becomes a tool to help you build your special system.

The package is designed to operate on an Apple II + (48K) and is compatible with Corvus, eight-inch Sorrento Valley and 5-1/4-inch disk drives. The system to run on the Corvus hard disk is priced at $449. The floppy disk version is $99.

ESP Computer Resources, Inc., 9 Ash St., Hollis, NH 03049. Reader Service number 474.

Pascal Billing System for the Apple II

The SoftCare medical billing system, which has been operating on minis and many Z-80 systems, is now available on the Apple II. SoftCare prepares patient bills and insurance claims, including Medicare and MediCal, for single or shared-practice doctor offices. Accounts receivable are maintained for patient and insurance carrier, and transaction detail is retained to permit tracking of individual claims. SoftCare accounts for partial payment of claims, write-offs and secondary insurance carriers.

Little or no operator training is needed. The fill-in-the-blank screen formats are self-explanatory. SoftCare guides the operator and does error checking as information is being entered. Moving from one function to another can be done at any time, from anywhere on the screen, using function keys shown on the screen. Patient files are updated as transactions are entered, so that bills and claims can be prepared on demand and reports can be run at any time. SoftCare can use patient names as a key, so that ID numbers are not required. The unique "browsing" capability lets you quickly and easily inquire and page through the files for access to up-to-date information. Set-up parameters tailor SoftCare to the doctor's practice. Procedure and diagnosis codes are user defined, with no limit on the number in the system.

SoftCare, written in UCSD Pascal, runs on the Apple II with Pascal language card and eight-inch disk drives or the Corvus hard disk. The price of SoftCare is $1995.

Professional Business Software, Inc., 119 Fremont St., San Francisco, CA 94105. Reader Service number 479.

Software for the TRS-80 Voice Synthesizer

Sayit adds voice output to BASIC programs on the TRS-80 Model I with the Radio Shack Voice Synthesizer. The program (5.5K of machine code) relocates itself in high memory of a 16K or larger machine without upsetting any installed custom drivers. It adds a SAY command which makes the synthesizer say string expressions, numeric expressions or any combination of the two. Simultaneous depression of the RTY keys will cause the current SAY statement to be spoken by the synthesizer.

The voice synthesizer is programmed using English letters. Normal English spelling will often be correctly pro-

Two new utilities from Image Computer Products.

nounced. Soundspelling can be used to force correct pronunciation: for example, the word BASIC sounds better soundspelled BAYSIK. Stress can be added within words to make them sound even better —BAY!SIK. For maximum precision, an optional symbol set based on the International Phonetic Alphabet can be used. The program also provides a talking keyboard which echoes each key struck. This feature is useful for teaching touch-typing or where visual feedback of keypresses is not possible. Sayit and manual are priced at $125.

BAYSIK Speech, Suite 289, 1259 El Camino Real, Menlo Park, CA 94025. Reader Service number 469.

Apple 2D-3D Graphics

A software program that brings professional multidimensional graphics capability to Apple II personal computers is offered by Apple Computer, Inc., 10260 Bandley Drive, Cupertino, CA 95014. AppleGraphics II is a versatile programming tool designed to help you prepare computer programs which generate two-dimensional and three-dimensional graphics. It lets you see a multidimensional object from any angle. Programs developed using AppleGraphics II can be used by architects to design buildings, by drafting professionals to prepare plans and by scientists to conduct experiments. You can also call up a full-screen view of any portion of a drawing, with no degradation of picture quality, for detailed study. For demanding applications requiring high-resolution hard copy, the AppleGraphics and Apple II system can be used with the most advanced plotters; AppleGraphics supports device-independent graphics protocol.

Requires 48K Apple II, video display and disk drive. Priced at $95. Reader Service number 477.

Space Games for the Color Computer

Computerware, Box 668, 1512 Encinitas Blvd., Encinitas, CA 92024, is offering Color Invaders on cassette for the Radio Shack Color Computer. This game puts you at the controls of the space tank, where you fire at stellar ships and invading critters. Invading ships burst in air with explosive sound. Alien critters march across the screen, drop their bombs and scream with pain when you zap them. Each of the eight levels of play further complicates the game, to keep the beginner going and challenge the expert.

Color Invaders is priced at $19.95, and requires use of the Radio Shack Power Pack. Reader Service number 467.

Utility Programs for The Apple II

Disk Fixer and Monitor Extender are machine-language programs which enable the

80 COLUMN GRAPHICS

The Integrated Visible Memory for the PET has now been redesigned for the new 12" screen 80 column and forthcoming 40 column PET computers from Commodore. Like earlier MTU units, the new K-1008-43 package mounts inside the PET case for total protection. To make the power and flexibility of the 320 by 200 bit mapped pixel graphics display easily accessible, we have designed the Keyword Graphic Program. This adds 45 graphics commands to Commodore BASIC. If you have been waiting for easy to use, high resolution graphics for your PET, isn't it time you called MTU?

K-1008-43M Manual only $10 (credited toward purchase)
k-1008-43 Complete ready to install package $495

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Write or call today for our full line catalog describing all MTU 6502 products, including our high speed 8" Floppy Disk Controller for up to 4 megabytes of PET storage.

The image on the screen was created by the program below.

```
 10 VISMEM: CLEAR
 20 P=160: Q=100
 30 XP=144: XR=1.5*3.1415927
 40 YP=56: YR=1: ZP=64
 50 XF=XR/XP: YF=YP/YR: ZF=XR/ZP
 60 FOR ZI=-Q TO Q-1
 70 IF ZI<-ZP OR ZI>ZP GOTO 150
 80 ZT=ZI*XP/ZP: ZZ=ZI
 90 XL=INT(.5+SQR(XP*XP-ZT*ZT))
100 FOR XI=-XL TO XL
110 XT=SQR(XI*XI+ZT*ZT)*XF: XX=XI
120 YY=(SIN(XT)+.4*SIN(3*XT))*YF
130 GOSUB 170
140 NEXT XI
150 NEXT ZI
160 STOP
170 X1=XX+ZZ+P
180 Y1=YY-ZZ+Q
190 GMODE 1: MOVE X1,Y1: WRPIX
200 IF Y1=0 GOTO 220
210 GMODE 2: LINE X1,Y1-1,X1,0
220 RETURN
```

MTU ⟋154

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NOW 80 COLUMN PETS CAN HAVE MTU HIGH RESOLUTION GRAPHICS

experienced programmer to manipulate, protect and display data. Disk Fixer provides easy access to either 13- or 16-sector formatted disks on either the track or sector level. The user is allowed sector-by-sector access to named files. Sector information can be displayed in hex, ASCII or a mixture of both. Price is $29.95.

Monitor Extender is a handy programming tool that enhances the capabilities of the Apple II monitor ROMs. Memory can be displayed in ASCII or binary. A range of memory can be disassembled into an ASCII file in memory, creating a labelled file that can be used for assembler source code. Monitor Extender is $19.95.

Image Computer Products, 615 Academy Drive, Northbrook, IL 60062. Reader Service number 476.

Word Processing Program

The Executive Secretary word processor, from Aurora Systems, Inc., 2040 E. Washington Ave., Madison, WI 53704, runs on Apple II with Applesoft and disk drives, any lowercase adapter or 80-column video board and shift key modification. It features versatile pagination and header printing, global search and replace, file merge and unmerge, block operations (move, transfer and delete) and spooling. It has a built-in card file system. The Executive Secretary interfaces with Data Factory, On-Line Database, Information Master and VisiCalc files. It provides automatic tabbing, dynamic text reformatting, immediate mode configuration for display screen, number of disk drives and printer, and it interfaces with CCS clock board for time stamping of documents. It also provides a built-in interface to D. C. Hayes Micromodem. Executive Secretary is priced at $250. Reader Service number 480.

Programming Aid For North Star

Info-System lets you develop your own software without any programming experience. All instructions are screen prompted. Just follow the cursor—your program is set up for you automatically. Info-System creates and initializes all files for you. All files can be updated, changed or deleted at your command. You can design the format for your printed reports. All information can be directed to the screen or to the printer. The system is flexible and easy to use. Info-System is written in North Star BASIC and requires 24K and two disk drives. Price is $95.

Omni Software Systems, Inc., 146 North Broad St., Griffith, IN 46319. Reader Service number 473.

A BASIC Compiler For OSI

FBASIC runs under the OS-65D3 operating system, with full access to all system facilities. FBASIC is a super-fast integer subset of OSI/Microsoft BASIC which is well suited to systems-level programming. It produces stand-alone 6502 machine-code modules. Features include user-definable array locations, WHILE loops, GOTOs and GOSUBs to absolute addresses and direct access to registers. It also links compiled modules to the OSI interpreter. The FBASIC compiler is disk based and can produce programs larger than available memory. Requires 48K of memory. Available on eight-inch floppy disk for $155.

Pegasus Software, PO Box 10014, Honolulu, HI 96816. Reader Service number 472.

Computer Epic

Empire of the Overmind is a computer fantasy game set in an ancient world where time has no meaning and the good King Alcazar ruled his kingdom nobly. Alas, one day a gray cloud settled upon Alcazar and his ministers were corrupted. The Overmind is the archvillain of the game. The Overmind is part machine, part spirit of evil, a dark angel striking terror into the heart of any foolhardy adventurer who dares to rectify the havoc he has wrought. The

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Apple IEEE Card	$ 339	25%
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Apple Clock/Calendar Card	$ 239	15%
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16K RAM Card	$ 159	20%
Hayes Micromodem II™	$ 299	23%
10 Memorex 5" Diskettes	$ 25	45%
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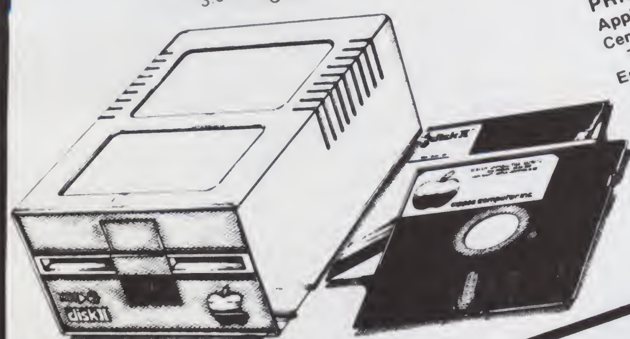

✓341

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References:
We have been an Apple dealer since 1978. Our bank reference is First Interstate Bank (503) 776-5620. We belong to the Chamber of Commerce (503) 772-6293.

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✓See List of Advertisers on page 194

CLUB NOTES

The Apple Guild

The Apple Guild for Apple users and owners supports a sophisticated, computerized, telecommunication system (617-767-1303); maintains a collection of hard-copy material and software at its Apple Resource Center located at Massasoit Community College (Brockton, MA); and publishes a quarterly journal. Membership requests and other inquiries should be sent to: PO Box 371, Weymouth, MA 02188.

Micropolis User's Group

The Micropolis User's Group (MUG) is entering its second year of service offering its members a monthly newsletter, discounts, library disks and vendor and membership directories. For further information, contact Buzz Rudow, Micropolis User's Group, 604 Springwood Circle, Huntsville, AL 35803. 205-883-2621.

Malibu Printers

Anyone owning a Malibu printer and wishing to join a user's group should contact Tom Wade, 6030 Fennell Ave., San Diego, CA 92114. The purpose of the club is to facilitate communication with the manufacturer and to exchange ideas, fonts and complaints.

New RI Club

Apple users will be interested to note that a new computer club is forming in Rhode Island. The club will publish the National Apple Newsletter for owners and users of Apple II or Apple II + computer systems. For further information, contact Scott Summer, 27 Leicester Way, Pawtucket, RI 02860.

OSI User's Group of Southern Ontario

The OSI User's Group of Southern Ontario has recently released its meeting schedule for 1981/2. The group will meet Sept. 5, Dec. 5, March 6 and June 5. For more information call Dr. N. Solntseff or Mr. C. Bryce, Unit for Computer Science, McMaster University, Hamilton, Ontario L8S 4K1 Canada (416-525-9140, ext. 4689 or 2065).

Homebrew Computer Club of Europe

The first East-European micro club, called the Homebrew Computer Club of Europe, has been founded for producers and users of 6800, 6809, Z-80, 8080, 8085, 6502 and F8 micros. For further information contact Dr. Endre Simonyi, 19 Trencsenyi, Budapest, H-1125, Hungary (0361 369183).

rhyme of Overmind tells the story of Alcazar's downfall and gives the player clues to guide the play. Empire of the Overmind cassettes for TRS-80 Model II, Apple II and Atari 800 are $30; disks are $35.

The Avalon Hill Game Company, 4517 Hartford Road, Baltimore, MD 21214. Reader Service number 466.

Apple Interactive Data Analysis

AIDA is a full-featured statistical analysis system for the Apple II, designed to perform data manipulation and statistical analyses needed in academic and marketing research. The program builds self-descriptive data files on the disk, then recalls variables by a virtual memory process as they are referenced by the user. Up to 11,000 data points can reside in memory at one time, allowing a maximum of over 4000 cases in analysis. Subsetting, transformation, missing data and case weights are supported.

Statistics include mean, variance, distributions, histograms, two-way tables (with chi-square), Pearson and rank correlation, pair and standard t-tests, ANOVA and multiple linear regression. It uses provisional means algorithms for accuracy of variances and cross-products, and computes significance levels. Data can be input from data files or through an enter and verify routine. Requires 48K with Applesoft and one disk drive. Price is $235.

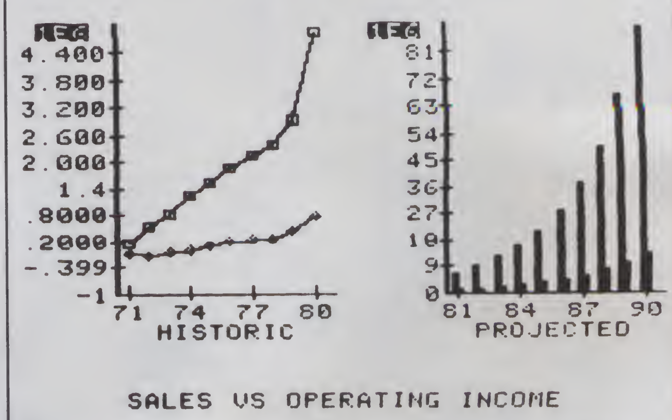
Action-Research Northwest, 11442 Marine View Drive, SW, Seattle, WA 98146. Reader Service number 478.

Business Software

Four new software packages for business use have been introduced by Personal Software, Inc., 1330 Bordeaux Drive, Sunnyvale, CA 94086. VisiPlot is a high-resolution plotting and graphics package; VisiDex is a flexible personal information system; the VisiTrend/VisiPlot program combines VisiPlot graphics with a program for time-series manipulation, trend forecasting and descriptive statistics; and the VisiTerm program enables a personal computer to communicate with mainframes and micros.

A major feature of the programs is the ability to pass information between programs. VisiPlot and VisiTrend can share data directly with the recently updated VisiCalc program. Using VisiTerm as a terminal, program files from VisiCalc, VisiPlot and VisiTrend/VisiPlot, or files created with VisiDex, can be sent between computers over phone lines or other connections.

All four programs operate on the Apple II and Apple II + with 48K, and are 16-sector compatible, with or without Apple's Language System. VisiDex and VisiTerm require one disk drive. VisiPlot and VisiTrend/VisiPlot require two disk drives and Applesoft BASIC. Prices are: $199.95 for VisiDex; $179.95 for VisiPlot; $259.95 for VisiTrend/VisiPlot; and $149.95 for VisiTerm. Reader Service number 481.



Sample printout from the VisiPlot and VisiTrend/VisiPlot programs, two of Personal Software's new business packages.

CORRECTIONS

Zoltan Szepesi of Pittsburgh, PA, has noted two line corrections to the program listing in "The Fifteen Puzzle" (February 1981, p. 114). Line 5080 should read:

```
5080 IF A(X) = 16 T. S = S + 1
```

Also, the following two statements should be added to the program to prevent a jump from the last block of a row to the first block of the next row and vice versa:

```
7012 IF (X = 4 OR X = 8 OR X = 12) AND
     A(X + 1) = 16 THEN RETURN
7013 IF (X = 5 OR X = 9 OR X = 13) AND
     A(X - 1) = 16 THEN RETURN
```

* * * * *

The subscription price of a year of *Kilobaud Microcomputing* as printed in the May 1981 issue (p. 210) is incorrect. *Kilobaud Microcomputing* still costs $25 for one year.

Applesoft Compiler

Expediter II provides an easy means to translate Applesoft BASIC programs into machine language. The compiled version will run from two to 20 times faster. All features of Applesoft are fully supported, including high resolution graphics, shape tables, low resolution graphics, defined functions and DOS commands. There is no additional BASIC syntax to learn, and most compilations can be performed with one simple command.

The Expediter II compiler makes extensive use of preexisting routines within the Applesoft ROM; this minimizes the memory required by compiled machine code. Applesoft programs can be compiled to reside at any location in memory, so multiple Applesoft programs can overlay each other and use the compiled Applesoft programs as subroutines. Comprehensive statistics are generated at compile times such as total memory requirement and starting address of the compiled machine code for each line of the Applesoft program. Price is $99.95.

On-Line Systems, 36575 Mudge Ranch Road, Coarsegold, CA 93614. Reader Service number 482.

Integrated Circuit Info on Your Apple

Lamar Instruments, 2107 Artesia Blvd., Redondo Beach, CA 90278, has a new program that will quickly provide engineers, technicians and computer hobbyists with needed information. Chips contain pinouts and truth tables, where applicable, for over 100 TTL and CMOS integrated circuits. Any of these can be displayed in less than three seconds, using Apple's high-speed 6502 machine-language search routines. New pinouts and truth tables are easily added to the existing list using examples provided in the program. Chips is available on floppy disk for the Apple II or the Apple II+ for $49.95. Reader Service number 475.

CLASSIFIEDS

Classified advertisements are intended for use by persons desiring to buy, sell or trade used computer equipment. No commercial ads are accepted.

Two sizes of ads are available. The $5 box allows up to 5 lines of about 35 characters per line, including spaces and punctuation. The $10 box allows up to 10 lines. Minimize use of capital letters to save space. No special layouts allowed. Payment is required in advance with ad copy. We cannot bill or accept credit.

Advertising text and payment must reach us 60 days in advance of publication (i.e., copy for March issue, mailed in February, must be here by Jan. 1). The publisher reserves the right to refuse questionable or inapplicable advertisements. Mail copy with payment to: **Classifieds, Kilobaud Microcomputing, Peterborough NH 03458.** Do not include any other material with your ad as it may be delayed.

Hardly-used Hayes Micromodem for Apple. Like new! Only $285. Still has unused warranty card! Also Centronics 737, like new, only $700. For $85 more you can have the Apple interface & cable. Howard Rothman, 218 Huntington Road, Bridgeport, CT 06608. 203-333-6436.

For Sale: TRS-80 and interface video display and all conn. 16K, Level II, manuals, extras. Like new $900. W. Wright, 6362 San Diego Ave., Riverside, CA 92506. 714-781-5863, wk. ends.

Three 8K S-100 memory boards. $125 each. For information on these quality S-100 boards contact: Richard A. Bockholt, 13275 South Street, Draper, UT 84020. 572-0590.

IBM/ESCON Selectric typewriter (correcting, w/legal keyboard) both 8 months old. Factory installed RS232C interface w/backspace and tab. In new condition, just too slow for my purpose. $1600. J. Turner, 309 Mac Corkle Ave., Saint Albans, WV 25177. 304-776-3675.

Axiom printer, Model EX801P (parallel). Great, trouble-free printers; new, in original boxes, my project cancelled. $425 each, or all four (4) $1600. J. Turner, 309 Mac Corkle Ave., St. Albans, WV 25177. 304-776-3675.

For Sale: 8 Godbout 8K Econoram II $43 each postpaid. Hazeltine 2000 CRT $500 FOB. Compucolor 8001, 19" CRT, 8 colors, 192 × 160 resolution, large keyboard with numeric pad, cursor control, BASIC, $1200 FOB. Make offer. D. G. Kissinger, School of Health, Loma Linda Univ., Loma Linda, CA 92350. 714-796-7272.

For Sale: Complete system. IMSAI 8080 computer with 64K memory, Lear Siegler ADM-3 terminal, and Altair disk drive. Good condition. Best offer. Jim Fritz, 1413 Harmony Lane, Annapolis, MD 21401. 301-757-7019.

For Sale: LA-36 Decwriter, excel. cond., RS-232 or current loop: $790. ASR-38 Teletype, good cond.: $225. KSR-38 Teletype, fair cond.: $175. UDS type 202 modems: $95. Optical paper tape reader, make an offer. Documentation but not shipping included in all prices. D. Monroe, 426 Maquan St., Hanson, MA 02341. Call 617-293-2885, weekends best.

Exatron stringy floppies for TRS-80. Two for sale. Both like new. Complete setup. Owner's manual, cable, 15 blank tapes. $150 each. Jane Caldwell, 411 Rembert St., Demopolis, AL 36732. 205-289-0756.

For sale—Zenith/Heath H-11 system, 64K RAM, two eight-inch floppy drives, HT-11 and Pascal software. Fully DEC PDP-11/03 compatible. $4200. 215-248-0439, evenings.

For sale: ASR-33 teletype with stand and service manuals. Reads and punches paper tape. Good condition. $200 plus shipping. Dick Carney, 1927 Dewey, Bartlesville, OK 74003. 918-336-3731.

For Sale: One set *Kilobaud Microcomputing* issues #1–52, missing #14. All in excellent shape. Best offer. S. Alter, 105 Southgate Circle, Massapequa Park, NY 11762.

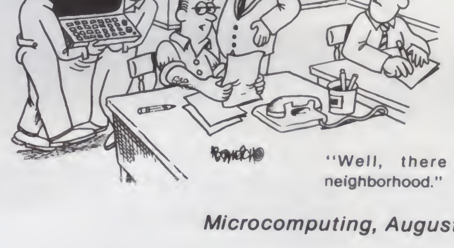
For Sale: Heavy duty IBM Selectric I/O terminal (GTE Novar). Very good working condition: includes manuals. $275. Call Jim at 617-692-7541.

For Sale: Exidy Sorcerer—32K RAM (includes all hardware schematics), some software, two cassette recorders and interfacing. Video 100 (12") monitor. Basic ROMpac and EPROMs for assembler pac. $850. Contact Al Schmidt, Rt. #3, Box 206, Oswego, IL 60543. 312-554-3044.

For Sale: Texas Instruments 990/4 computer floppy development system. Includes dual 8-inch floppy disk drives, 990/4 CPU, 810/4 printer, bell data set interface, two TMS 1000 incircuit emulators with debug, 9900 time share pers. module & paper tape reader, and power basic module. Orig. val. $24,000; asking $12,000 or best offer. Contact: Howard Morrison, Marvin Glass & Associates, 815 North LaSalle Street, Chicago, IL 60610. 312-664-8855.

For Sale: SWTP 6800 computer 28K PR40 printer, 7mp boards, CT64 term Sanyo mon—AC30& CIS30+ interfaces. Extras—CPU board w/Z-80 chip; 6809 CPU board (Percom); SWTBUG-RT68 mon., S32 blank memory board (SWTP). Best offer over $600. 301-367-2760, after 5 pm. C. N. Harrid, PO Box 3021, Baltimore, MD 21229.

For Sale: Digital group Z-80 system, 34K (expand. to 50K by adding chips), TVC-F video readout and cassette interface, 4 parallel and 4 serial ports, dual 8-inch floppy-disk system, MCOS, FORTRAN, Maxi-BASIC, Z-80 assembler, Sargon chess, text editor & formatter. Documentation on all hardware and software. Selectric terminal (not working). $3500 or best offer. DeWayne Smith, 714-792-2703 or 714-793-2853 (work). Redlands, CA.



"Well, there goes the neighborhood."

✓See List of Advertisers on page 194

Computer Arts Festival

The Personal Computer Arts Festival, held in conjunction with the Personal Computing '81 Show at the Philadelphia Civic Center, Aug. 28–30, will feature technical sessions, demonstrations and exhibits, as well as the annual computer music concert and computer graphics film/video show. Computer musicians and artists who would like to speak, exhibit or perform at the festival should contact PCAF '81, Box 1954, Philadelphia, PA 19105.

National Computer Shows

The National Computer Shows has announced its fall schedule of trade and public expositions for manufacturers, OEMs, distributors, dealers and retailers selling small, medium and large computers for business, industry, government and education. The shows feature office systems, data and word processing equipment, telecommunications equipment, electronic typewriters, computers for scientific and engineering applications, microcomputers, computer graphics, computer peripherals, accessories, supplies and software. The shows are: the Second Annual Midwest Computer Show, Sept. 10–13, at Chicago's McCormick Place; the Second Annual Mid-Atlantic Computer Show, Sept. 24–27, at Washington's DC Armory; the Third Annual Northeast Computer Show, Oct. 15–18, at Boston's Hynes Auditorium; and the Southeast Computer Show, Oct. 29–Nov. 1, at the Atlanta Civic Center. Contact the National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, 617-739-2000.

Software Info '81

Software Info '81, the National Software Package Conference and Exposition, will be held Sept. 14–17 at Chicago's Merchandise Mart Expocenter. Software product exhibits, seminars and speeches are slated. For more information, contact Software Info, 1730 N. Lynn St., Suite 400, Arlington, VA 22209, 703-521-6209.

Personal Computer Show

The 4th Personal Computer World Show will be held at the Cunard Hotel, Hammersmith, London, from Sept. 10–12. Further information can be obtained by writing Timothy Collins, Personal Computer World Show, 11 Manchester Square, London W1E 2QZ.

IEEE Computer Society Conference

"Productivity—An Urgent Priority" is the theme of the IEEE Computer Society Compcon Fall '81 to be held Sept. 14–17 at the Capital Hilton Hotel, Washington, DC. Contact Compcon Fall '81, PO Box 639, Silver Spring, MD 20901, 301-589-3386.

Electronic Learning Conference

The Association of Media Producers will spotlight electronic learning in a conference scheduled for Sept. 23–25 in Washington, DC. "Technology Revolution: Education And Training" will focus on microcomputers, cable TV and video disks or tapes. For information, call the AMP at 202-857-1195.

Ham/Computerfest

The 1981 Golden Spread Hamfest and Convention, sponsored by the Panhandle ARC and the High Plains TRS-80 User's Group will be held Aug. 7, 8 and 9 at the Student Activities Center of West Texas State University in Canyon, TX. Amateur events include commercial displays, swapfest, ARES, station operating demonstration, Navy and Army MARS meetings, ARRL forum, TRS-80 user's group meeting and technical sessions. For further information, contact Carl Holtman, High Plains TRS-80 User's Group, PO Box 30546, Amarillo, TX 79120.

Midwest Computer Show

The Second Annual Midwest Computer Show & Office Equipment Exposition will be held Thursday–Sunday, Sept. 10–13, 1981, at Chicago's McCormick Place. The show features hardware, software and supplies for business, education, government, home and office use, plus office systems and office equipment. For more information, contact National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167 (617-739-2000).

Mid-Atlantic Computer Show

The Second Annual Mid-Atlantic Computer Show & Office Equipment Exposition will be staged Thursday–Sunday, Sept. 24–27, 1981, at the Washington DC Armory/Starplex. Exhibits will include hardware, software and supplies for business, education, government, home and office use, plus office systems and office equipment. The show is produced by National Computer Shows, 824 Boylston St., Chestnut Hill, MA 02167, 617-739-2000.

Software Symposium

Queue's second annual Educational Software Symposium is set for Oct. 15–16 at the Stouffer's Inn in White Plains, NY. The symposium will feature education software from dozens of publishers on display for review and purchase. There will also be a wide variety of seminars, panels and user interest group meetings on such topics as designing educational software, evaluating educational software, computers in the elementary classroom, computers in various curriculum, including math, science, English and foreign language. Registration is $45 in advance, $55 at the door. Contact Monica Kantrowitz, President, Queue, Inc., 5 Chapel Hill Drive, Fairfield, CT 06432.

Computers and Medicine

Computers in Ambulatory Medicine is the topic of the Joint Annual Conference of the Society for Advanced Medical Systems and the Society for Computer Medicine, Oct. 31–Nov. 1 at the Washington Sheraton, Washington, DC. Selected contributed papers, topic oriented sessions, basic and advanced tutorials on fundamentals of medical computing. Fee is $115 members, $165 non-members. For information write SCM, 9650 Rockville Pike, Bethesda, MD 20014, or call 301-530-7120.

Computers for Lawyers

"Legal Info," the first national conference and exposition dedicated to automating legal information systems, is scheduled for Dec. 1–3 at the Shoreham Hotel in Washington, DC. For more information, write "Legal Info," 1730 North Lynn St., Suite 400, Arlington, VA 22209, or call 703-521-6209.

RIT Courses for Deaf

Rochester Institute of Technology (RIT) will offer two computer courses for deaf adults this summer through the National Technical Institute for the Deaf (NTID). Introduction of Data Processing will be offered Aug. 3–7. Advanced Data Processing will be offered Aug. 10–14. For more information contact Donald Beil, NTID Data Processing Dept., Rochester Institute of Technology, One Lomb Memorial Drive, Rochester, NY 14623, or call 716-475-6373 (voice or TTY).

MICRO QUIZ

(from page 8)

Answer: ECCS

right$ ("NECSL",3) = "CSL"
B$ = left$ ("CSL",2) = "CS"
C$ = mid$ ("NECSL",2,2) = "EC"
B$ = "EC" + "CS" = "ECCS"

CP/M Primer
Real-Time Programming
Program Structure and Design
Computers Can Make You Rich
The Book of Apple Software

CP/M Primer

Stephen M. Murtha & Mitchell Waite
Howard W. Sams & Co., Inc.
Indianapolis, IN, 1980
Paperback, 92 pp., $11.95

Digital Research has provided the microcomputer world with an eminently successful software product in the CP/M operating system. Everything the CP/M user needs to know about the system is contained in the set of manuals included with the software. Unfortunately, those manuals are not organized or written in a manner understandable to the novice programmer or computer user. As more and more inexperienced personal computer users are acquiring CP/M-based machines, there is a need for a guide to CP/M that is understandable by the beginner.

The *CP/M Primer* is an outstanding example of how to write a technical book for the beginner. It guides the reader step by step through the subject, explaining what CP/M is and how to use it.

As the authors point out, *CP/M Primer* does not replace the Digital Research manuals. Some topics, such as modifying the system for a specific hardware environment or the use of the PUN: and RDR: devices, are not even covered. But these topics are for the more advanced programmer, who will be able to find all the additional information he needs in the more detailed manuals. Where the *CP/M Primer* does not include all these details, references are made to the appropriate sections of the Digital Research manuals.

What the novice user has always needed is a guide to using CP/M written for normal mortals, as opposed to expert programmers. While all the cutesy cartoons in this book don't do much to achieve that goal, the more technically correct diagrams and simulated CRT screen displays certainly do. The friendly, informal tone of the text makes the reading easier, without detracting one bit from technical accuracy.

This brings up a very important point: accuracy. In past book reviews in *Microcomputing* I have blasted other publications as being worthless or insulting to the reader. These judgments are made primarily on the basis of the percentage of misinformation contained in a book, which I find inexcusable.

"Refreshingly enjoyable" is, therefore, the feeling generated by reviewing *CP/M Primer*. While it is readable and understandable, this book is also incredibly accurate. To achieve such accuracy, the authors had to know their subject intimately. They also had to be talented at presenting a technical subject in such a well-organized and readable manner.

What Stephen Murtha and Mitchell Waite present so accurately are all the instructions you will need to operate a computer running CP/M. Quite often you will use the operating system only for its file-handling capabilities, running BASIC or some other higher-level language. The first five chapters cover all the information you will need to make full use of CP/M at this level.

When you are ready to go on to assembly-language programming, chapters 6 through 8 will guide you through operating the editor, assembler and debugger included with CP/M. (You will not be able to learn assembly-language programming from these chapters alone, however. For that you will also need a book like Intel's *8080 Assembly Language Programming Manual* that will tell you what all the microprocessor instructions will do.) The *CP/M Primer* will tell you how to enter and edit your source program, assemble it and debug the resulting machine-language program. Chapter 8, on the DDT debugger, is one of the highlights of the book, explaining a difficult subject completely and concisely.

Some more intricate insights into the internal structure of CP/M are included in an appendix, where such details belong. The appendix mentions the differences between versions 1.4 and 2.0. Again, the superb organization of topics and clarity of the presentation provide the reader with a framework on which to hang the numerous details he will have to dig out of the turbid Digital Research manuals.

This book was written to fill a real need and it fills that need more than adequately. It is accurate, readable, understandable and indispensible. Don't stay home without it.

Ken Barbier
Borrego Springs, CA

Home Computers Can Make You Rich

Joe Weisbecker
Hayden
Rochelle Park, NJ, 1980
Paperback, $6.50, 122 pp.

Of the hundreds of thousands of today's microcomputerists, a healthy majority probably entered the field with the vague idea that somehow there was money to be made with small computers. At least I did; and when I spotted this paperback on my local bookstore's shelf I bought it, albeit

with mixed feelings of optimism and skepticism. I was neither disappointed nor surprised.

After an introductory overview of the microcomputer industry, Weisbecker devotes a chapter to some useful considerations on making money. He warns of pitfalls and failure-prone behavior patterns, and he describes what he calls "luck management;" a way of optimizing one's chances to succeed. But the big message of this chapter bears repeating here:

> If you are going to sell products, sell services, or create new ones, there are two basic principles you should know about:
>
> 1. Find a need and fill it at a reasonable cost.
> 2. Never overestimate the intelligence of your customers.

The next chapter, on resources, discusses books, magazines, stores, clubs, user groups and shows which the reader can use for basic education and for sources of money-making ideas. A few specific book and magazine titles on computers are suggested, as are several key reference aids for authors.

The real meat of the book is contained in the middle chapters entitled "Writing for Money," "Creating and Selling Programs," "Services for Sale" and "Use Your Imagination." In these pages Weisbecker gives advice and suggestions on a wide range of concerns: writing nontechnical vs software/construction articles; royalty agreements vs outright sale of programs; marketing programs through hardware manufacturers vs software and magazine publishers. I found especially apt his ideas on operating a microcomputer rental service for students, for use at parties, or for merchant displays.

The final three chapters cover various topics, but are all strongly profit-oriented. In "Invent Your Way to Success," the author discusses at some length his own favorite way of making money with computers. "Making Your Money Grow" urges the reader toward stock market investment of profits (earned, of course, by implementing the book's ideas), using the microcomputer to maximize return. In "Working at Home," equipment, supplies and reference books for the home-based office are discussed briefly, and the undeniable need for self-discipline is stressed.

The book is by no means flawless. I found several distracting typographical errors—none, however, that distorted meanings. The section on opportunities for computer consultants is of questionable utility. What qualified consultant would feel the need to read this kind of book? Also, it seemed to me unnecessary to advise a hardware hacker to get himself a soldering iron. These are mere quibbles, to be sure. What is more serious is that a book about making money doesn't have a chapter on simple bookkeeping. Perhaps one or more of the suggested readings covers this subject, but I'd like to see the topic covered in this book.

Yes, I was skeptical that this book would deliver on its promise. It certainly is not a detailed, foolproof, get-rich-quick scheme. But, the book is well worth its modest price. Weisbecker has covered thoroughly, if not exhaustively, the many broad categories of money-making activities, and within those categories he has suggested specific applications quite imaginatively. Few will become suddenly wealthy as a result of reading this book, but there are plenty of ideas here to point a self-starter in the right direction. As the author says, "Think of the current phase of the microcomputer industry as your opportunity to develop the skills that can make really big money for you in the future."

Dennis C. Cullinan
East Lansing, MI

Real-Time Programming with Microcomputers

Ronald C. Turner
Lexington Books
D. C. Heath & Co., 1978
Hardcover, 168 pp.

Ronald Turner set out to accomplish quite a task: to write a book that spans the "no-man's land" between the separate worlds of the hardware designer and the software designer. Although this book might not be the ultimate text in that area, I feel Turner has accomplished his goal quite admirably. Better yet, his writing is concise, understandable and often humorous, so it reads well whether you are a professional or a hobbyist.

This book is about interface software drivers. Real-time in the text refers to events requiring attention from the microcomputer but occurring asynchronously with the internal timing of the microcomputer. Please note that you will find no fancy programming gimmicks in this book. Instead, emphasis is put on structured, easy to read and easy to modify code.

The microprocessor used in the examples is the 8080, and code examples in PL/M are used where advantageous. Before all of you who use processors other than the 8080 wander on to the next review, let me state that this is not a programming manual for that microprocessor. Its instruction set is examined, but only as a means to discover ways to manipulate data.

Topics covered include choosing between a polled or interrupt-driven system, establishing a communications protocol between the microcomputer and peripheral devices, data manipulation and control of program flow. Special emphasis is placed on establishing a concise system of communication between devices and tightly structured (therefore easily modified) program blocks in these discussions.

The last section of the book deals with top-down program design, and has practical exercises in designing software for dedicated real-time systems. Three general-information appendices and answers to selected questions in the book are also included at the end.

This book should be valuable to anyone, regardless of their chosen family of microprocessor devices. I say this because of the impact Turner has had on my programming style. I find that since reading his book, problems in programming I/O drivers for my 6502 are much more easily broken down into solvable steps. This book would be a good addition to the library of anyone who is involved in writing peripheral-driving software.

Thomas Franks
Wadsworth, OH

Techniques of Program Structure and Design

Edward Yourdon
Prentice-Hall, Inc.
Englewood Cliffs, NJ
Hardcover, 364 pp., $24.95

It's a dry, academic-sounding title, but thanks to the author the content is readable, entertaining and informative. This is a practical book, punctuated with humor and anecdotes, that reveals the mysteries of structured programming. It assumes that the reader is basically familiar with computer hardware and various programming languages (i.e., assembler, Fortran, COBOL, PL/1, ALGOL). However, you don't have to have an in-depth knowledge of all these languages to appreciate the book. The author is not concerned with language syntax and mechanics but with the frame of mind and concepts required for structured programming.

The elements of good programming—top-down design, modular programming, and simplicity and clarity of design—are discussed at length. After presenting the theory and techniques of structured programming, the author looks at the flip side of writing programs—getting them to work. A key device to prevent errors in the first place is antibugging. This "refers to the philosophy of writing programs in such a way to make bugs less likely to occur—and when they do occur (which is inevitable) to make them more noticeable to the programmer and the user."

The final two sections are entitled "Program Testing Concepts" and "Debugging Concepts and Techniques." They lay the groundwork for an organized, problem-solving approach to programming and debugging. The author humorously notes that:

> Tracking down a program bug is much like tracking down the murderer in an Agatha Christie mystery: Where massive manhunts and brute-force techniques of the local police force fail, the hero, M. Hercule Poirot, succeeds by employing the "little gray cells."

This book is not a beginner's programming tutorial, nor is it written specifically for the microcomputer hobbyist. But even if you're a neophyte programmer, you'll find it worthwhile to be exposed to these

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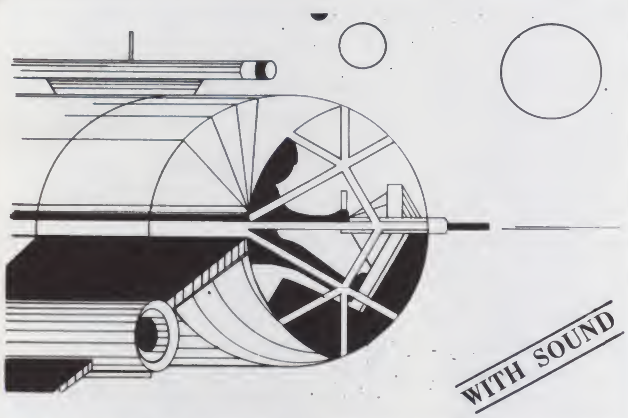

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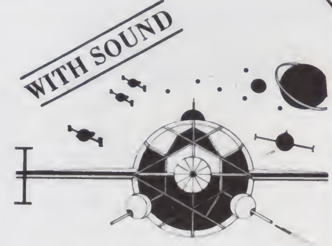

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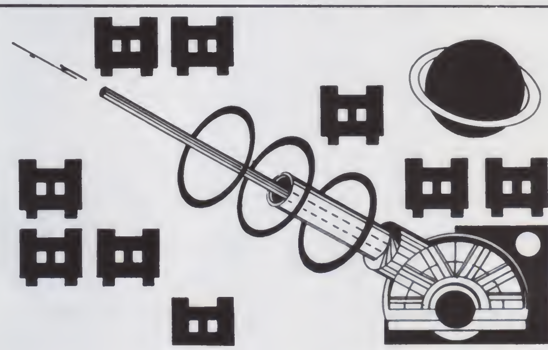

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ideas before you get caught up in sloppy habits. Those already into their programming careers will find this book a valuable introduction to the programming concepts of the 80s.

Fred La Point
Lansdale, PA

The Book of Apple Computer Software

James Sadler and Jeffrey Stanton
The Book Company
Softcover, $19.95, 243 pp.

One of the toughest tasks that a computer hobbyist has is choosing software. Hundreds of different programs are released each month—from games to business applications. Most people cannot take the time to evaluate these new programs, let alone the thousands of programs currently written. For the Apple owner this task has been made easier with *The Book* by James Sadler and Jeffrey Stanton.

The editors have done a noteworthy job of rating and describing the software available for the Apple II. The book is divided into eight sections, five of which deal with program reviews. These sections are Games and Entertainment, Education, Business and Utilities. Each section is further subdivided with the software logically grouped under their own heading. The other sections deal with how the software was rated, software under review and new products which may be evaluated at a future time.

Software ratings are the most important part of the book. Software is rated on a scale of 10 to 100, 10 being unacceptable, and 100 superior. The rating criteria used are what you would use if you went to a computer store to purchase the software. Ease of use, documentation and reliability are all used to evaluate the software, and these factors are also listed in the review, scored from 10 to 100.

One of the more interesting ratings is the price/usefulness ratio. The reviewers attempt to answer the question, can "a fair program from a vendor priced at $7.95 be a better value than only a slightly better program of the same type from another vendor priced at $24.95." This rating can be especially useful when looking at similar programs. In my opinion, the price/usefulness ratio is one of the most important aspects of this book.

Another nice feature is the comparison charts for word processing and assembler programs. A quick glance will list all the major features of the application rated side by side. These charts can be very helpful in selecting application software when there are many features.

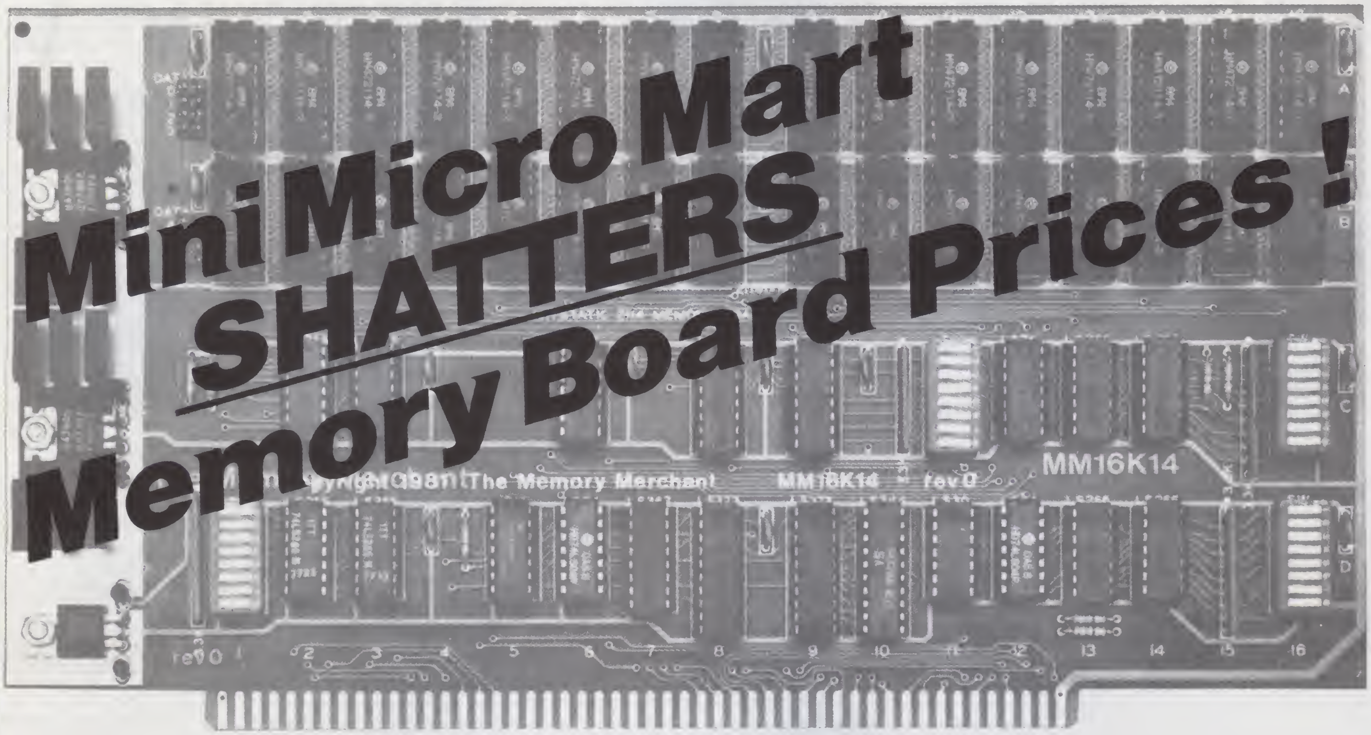
The major problem with all books of this type is staying up to date. The editors have found a way around this problem by offering quarterly updates. This service costs $15 a year.

On the negative side, the book is full of typos. Whole pages are duplicated within the book, often one right after another. Another flaw is the way the programs are reviewed. The reader is given a list of judging criteria, but nowhere is it mentioned if similar programs were tested against one another. Just as important, no qualifications are given of the reviewers. This may not be important for game programs, but can be critical for business applications where a poorly evaluated program, by an unqualified individual, may cause a company to lose a substantial amount of money.

I have mixed feelings about this book. It is very convenient to have a book that contains a review of almost all current Apple software. The quarterly updates are most appreciated in keeping *The Book* current. On the other hand, $34.95 for this book ($19.95 for the book, $15 for the updates) seems a bit much. There are just too many typos for a book at this price.

If keeping abreast with software is important to you, then buy *The Book*. I don't think that you will find as many programs rated and organized in any other book or magazine.

Robert J. Flynn
Riverdale, IL



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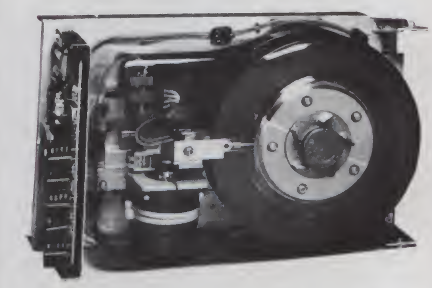

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PERSPECTIVES

By Don Langford

The STD Bus Is Coming!

Will It Replace The S-100?

Back in mid-1978, Mostek Corp. and Pro-log Corp. devised an industrial approach to the booming microprocessor world to satisfy a need. That need was for standardization of the several powerful microprocessors that had become prolific in industrial control and application. The concept was so well defined, so inflexible, that it created its own flexibility at the system level.

With standardization, no longer did small companies worry about boards from different sources not playing together. With few exceptions, the mix-and-match of a wide variety of boards became possible. Almost overnight, sources of peripheral and special function cards became available to the harried microprocessor engineer.

CPU cards included the Z-80, 8085, 8080, 6800 and 6809 as the most popular. Although memory cards are necessarily limited by their small size (4.5 × 6.5 inches), 32K and even 48K cards became available. Density is certain to increase with the coming new families of RAM, and even bubble memory is not far in the future.

The STD Challenge

The STD Manufacturer's Group (STDMG) is a voluntary industry association whose purpose is to try and maintain order, and promote and preserve the STD bus concept. Over 30 manufacturers belong, and there are estimates of over 100 sources of STD bus products.

There have been several feeble attempts to introduce STD boards to the hobbyist with notably poor response. S-100 has a strong foothold, especially with the hardware-oriented hobbyist. Other bus systems have their followings, and the STD bus will have a difficult job becoming accepted in the home and small-business computer markets.

Nevertheless, the movement is underway. A lot of engineers have built home systems with the STD bus after becoming familiar with it either through working with it or through the trade journals. A few manufacturers are starting to package complete systems. The first came with the manufacturer's development software; now most offer CP/M.

The problem STD manufacturers face is quantity. Board sales lend themselves best to OEM volumes with lots of follow-on orders. Manufacturers have just not been interested in catering to the hobbyist market.

The STD bus has no growth potential and will always be an eight-bit bus. The boards are basically limited to one function per board, causing a multitude of boards to be needed for a complete system. The manufacturers are reluctant to become involved in the hobbyist market.

But the scene is about to change. As more and more STD bus systems become available, the hobbyist and small-business users will become prime targets. The ease of use and versatility have no parallel with any other system. Mail-order houses and dealers will be able to offer custom systems to fit anyone's needs and growth plans. Designers and tinkerers may try their hand with specialty cards with little worry that their efforts will be limited only to their systems. Users won't be continually modifying to make their new gizmo board play.

No doubt about it, the STD bus is coming, and those who want a versatile, easy-to-use family of cards had better take a hard look at all the STD bus has to offer. The wait will be well worth it.□

Don Langford is an engineer who resides at 3915 Brookline Circle, Huntsville, AL 35810.

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